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Online service-learning versus face-to-face service-learning: learning gains in university students and associated predictors

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ABSTRACT

Service-Learning (SL) combines community engagement with academic learning, where students apply and consolidate their knowledge and skills through community services. Due to the COVID-19 pandemic, traditional face-to-face SL (FTF-SL) was replaced by remote online SL (e-SL). Although studies have supported the benefits of both FTF-SL and e-SL, direct comparisons and investigations of predictors of students' achievement in SL remain scarce. This study used data collected in China ($N = 115$) to explore the differences in outcome measures (i.e., positive attributes, leadership qualities, and life satisfaction) across students in the two SL modes. Additionally, we explored the predictors of students' changes in SL, focusing on collaborative learning, reflective learning, and course satisfaction. While positive changes were observed in the outcome measures for both e-SL and FTF-SL modes, greater improvement in leadership qualities and life satisfaction was found in the latter arrangement. Furthermore, collaborative learning, reflective learning, and course satisfaction positively predicted students' achievement in SL. These findings enhance our comprehension of the effectiveness of various SL delivery and inform the design and implementation of SL courses in online and FTF settings in higher education.

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Community service; e-SL; collaborative learning; reflective learning; course satisfaction

Introduction

Service-Learning (SL) combines academic learning with community engagement, requiring students to apply academic knowledge and skills to design and implement community services based on their comprehension of community demands. It has been globally recognized as an effective pedagogical strategy in higher education that promotes not only academic achievement but also personal and interpersonal growth as well as social and civic development (Choi et al., 2023; Hong, Wan, et al., 2024; Sotelino-Losada et al., 2021; Tan & Soo, 2020; Z. Zhu et al., 2022).

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Extensive research in Western contexts has revealed the positive impact of traditional face-to-face Service-Learning (FTF-SL) on students, including soft skills (e.g., communication, emotional management, and leadership qualities), civic responsibility, and well-being (Compare & Albanesi, 2023; Z. Li et al., 2023; Salam et al., 2019a; Sotelino-Losada et al., 2021; Z. Zhu et al., 2022). Compared with extensive evaluation studies in Western contexts, research investigating the impacts of SL on students and the related process in Asian regions, such as China, remains scarce. Further localized studies are essential to enrich the global SL community.

The COVID-19 pandemic has disrupted traditional classroom-based education, leading to a shift to online platforms (Daniel, 2020). This transition has also reshaped SL, giving rise to remote online Service-Learning or e-SL (Aykiri, 2022; Wong & Lau, 2024). E-SL, as an experiential learning method, facilitates virtual connections among students, educational institutions, community partners, and service recipients. It offers distinct advantages, including cost-effectiveness, easier accessibility, expanded partner and venue possibilities (by overcoming geographical barriers), enhanced security and privacy measures, as well as the promotion of digital citizenship (Faulconer, 2021). Nevertheless, the lack of in-person human touch in e-SL may limit effective interaction and communication, potentially affecting its effectiveness negatively (Schmidt, 2021). Despite the recent findings supporting the similar effectiveness of e-SL and FTF-SL (X. Li et al., 2023; Lin et al., 2023; Shek et al., 2022; Soffer & Nachmias, 2018; Stefaniak, 2020; Zhu, Wu, et al., 2024), most research has not compared students' changes concerning SL nature (i.e., online versus FTF). Thus, there is a need to compare students' experiences and changes in SL between online and FTF-SL formats, specifically in non-Western contexts.

Additionally, it is crucial to comprehend factors that influence students' achievement in SL. Course attributes, such as understanding the community, academic learning, interest in the project, perceived benefits for service recipients, and recipients' appreciation, have been identified as contributors to students' learning achievements (Moely & Ilustre, 2014; Ngai et al., 2018). Students who perceived higher course effectiveness also displayed greater changes (Lin et al., 2023). Moreover, students enrolled in the intensive SL course experienced greater gains than their counterparts in the regular course (Zhu, Wu, et al., 2024). Students' learning engagement (e.g., collaborative and reflective learning, which are key in experiential learning) and their subjective learning experience (e.g., satisfaction with the SL course) may also serve as potential predictors. Nevertheless, no study has empirically examined the predictive effects of these factors. Thus, this pioneering study aimed to address these research gaps by directly comparing students' changes in online and FTF SL courses and by exploring the effects of the three potential predictors on SL achievement.

SL in China

Although the concept and pedagogy of SL originated in Western academia, its core principles align closely with traditional Chinese cultural and educational philosophies. All SL theoretical frameworks aim to cultivate students into better individuals who are well-equipped to serve others after graduation (Shek, 2019). This objective resonates deeply with classical Chinese educational thought and cultural values that have profoundly influenced Chinese communities. For instance, the Confucian emphasis on *ren*

(benevolence), the collective-oriented values in traditional Chinese culture, and the educational philosophy of *zhixing heyi* (the unity of knowledge and action) proposed by the famous Chinese educationalist Wang Yangming all converge towards this purpose. SL harmonizes "service" and "learning", enabling students to expand their acquired knowledge while cultivating moral character, both of which guide action, reflecting Wang Yangming's principle of *zhixing heyi* (Tan, 2024). Furthermore, from a theoretical standpoint, Confucian moral psychology, particularly the concept of *ren* (benevolent care), which emphasizes self-discipline and social norms to cultivate compassion, responsibility, and harmony, provides a robust framework for understanding SL as an ideal pedagogical approach in the Chinese context (Preti, 2015). It aligns closely with SL's potential to foster moral sensitivity, moral motivation, and ethical conduct.

Furthermore, SL's educational philosophy aligns closely with the vision and direction of several key educational policies in China, thereby strengthening its relevance and applicability in this context. For instance, in a policy document issued on 25 September 2019, the Ministry of Education of the People's Republic of China (2019) explicitly emphasized that higher education should uphold the principle of integration and synergy to comprehensively enhance its capacity to serve socioeconomic development. Similarly, a document released by the Communist Party of China (CPC) Education Ministry Leading Party Members' Group (2017) reiterated that cultivating well-rounded, high-quality talents to serve society is a fundamental mission of higher education in China. These policies have facilitated inter-institutional collaboration in SL practices across different regions within the Chinese context, for example, the SL courses offered by the Beijing Normal University-Hong Kong Baptist University United International College (Chen & Zhang, 2018). In December 2023, the first national SL education network was established, connecting more than 20 universities and other partner institutions. The gradual increase in relevant policies also serves as a positive indicator, creating fertile ground for the broader promotion and adoption of SL in China.

Notably, SL has been increasingly incorporated into higher education courses across disciplines in Asian societies, including Hong Kong, Singapore, and South Korea (Choi et al., 2023; Hong, Wan, et al., 2024; Lo et al., 2022). With specific reference to China, initiatives aiming to adopt and promote SL in the higher education sector have been emerging in the past decade, including the implementation of different forms of institutional activities that integrate SL components (e.g., credit-bearing SL courses and SL trips and volunteer programmes), formation of national SL education networks, and organizing academic SL conferences (Hong, Wan, et al., 2024; Shek et al., 2020). These efforts have provided valuable opportunities for students to apply academic learning in real-world contexts and have also deepened the understanding of different stakeholders (e.g., educators, researchers, and community partners) in terms of both the benefits of integrating SL into university curricula and the importance of SL research in higher education.

By reviewing 52 studies on credit-bearing SL courses in the Chinese Mainland in the past two decades, Hong, Wan, et al. (2024) reported a steady growth in SL courses across the region. As of June 2023, these courses were distributed across seven geographical regions and 19 provinces, encompassing 36 discipline-specific courses and 16 general education courses. The SL courses included in Hong et al'.s (2024) review, along with other recent empirical studies (e.g., Wang et al., 2019, 2020), have benefited university students from the Chinese Mainland by enhancing their cognitive skills, knowledge, learning

transferability, social connectedness, and social responsibility. In this flourishing development, higher education practitioners in the Chinese Mainland have actively engaged in reflective practice, refining pedagogical strategies to optimize educational outcomes and promote teaching policies better suited to contemporary societal needs (Dai, 2018, 2022; Yao & Guo, 2015). Beyond the Chinese Mainland, emerging studies have documented the positive effects of SL courses on students from Hong Kong, reporting significant improvements in students' psychosocial competencies, value of learning, and leadership skills (Lo et al., 2022; Shek et al., 2020).

Nevertheless, compared with the large number of evaluation studies in Western contexts, research investigating the impacts of SL on students and related processes in Asia, such as China, remains insufficient. As a relatively new concept in the Chinese higher education environment, which is traditionally dominated by state-mobilized and state-sponsored volunteerism and often lacks formal academic integration (Zhao & Lilly, 2021), SL's development is nascent, and empirical studies on how students benefit from SL experiences in China remain notably limited.

SL pedagogy under two implementation modes

The theoretical foundations of SL and its focus on experiential learning are grounded in the philosophy of "learning by doing", which holds that personal development and transformation occur through the assimilation of knowledge from experience, thereby establishing behavioural patterns (Mortari & Ubbiali, 2021). Kolb's (1984) "experiential learning cycle", comprising the four iterative stages of "concrete experience, reflective observation, abstract conceptualisation, and active experimentation", provides a robust framework for experiential learning. During this process, concrete experiences and reflective thinking are regarded as essential factors for achieving optimal learning outcomes (Kolb, 1984). The experiential learning cycle is portrayed as a "learning cycle or spiral where the learner 'touches all the bases' – experiencing, reflecting, thinking, and acting – in a recursive process that is responsive to the learning situation and what is being learned" (Kolb & Kolb, 2005, p. 194). SL, as an educational method, operationalizes this cycle by engaging students in addressing real-world community needs. It integrates academic learning with civic goals, providing students with opportunities to apply knowledge, make decisions, and take actions that contribute to the community while fostering self-improvement through reflection (Anderson et al., 2019). As SL can benefit service targets and enhance community relationships while also promoting student participants' learning and development through meaningful services and critical reflection, it embodies reciprocity characterized by respect, trust, commitment, collaboration, interaction, and communication (Anderson et al., 2019). Thus, SL is regarded as one of the ten high-impact practices with the greatest potential to enhance student achievement in higher education, including in the Asian context (Anderson et al., 2019; Hong, Wan, et al., 2024).

Studies have extensively documented the positive impact of traditional FTF-SL on university students (e.g., Compare & Albanesi, 2023; Hong, Chen, et al., 2024; Sotelino-Losada et al., 2021). Earlier meta-analyses have confirmed that service providers benefited from FTF-SL projects, with significant improvements in self-worth, critical thinking, academic performance, social skills, and civic engagement (Salam et al., 2019a; Z. Zhu et al., 2022). Recent research also reported that FTF-SL fostered generic positive qualities (e.g.,

positive identity, emotional skills, and decision-making capacity), leadership qualities in terms of building character strengths, leading oneself (i.e., self-leadership), and caring for others, as well as well-being (e.g., life satisfaction) among university students in Western and Chinese contexts (Ma et al., 2019; Opazo et al., 2018; Shek et al., 2020).

In response to the COVID-19 pandemic, e-SL emerges as an alternative to FTF-SL. It adapts and implements the FTF-SL curriculum in online environments, leveraging Kolb's experiential learning cycle as its core conceptual framework (Faulconer, 2021). E-SL offers the advantages of accessibility and flexibility, removing physical and geographical barriers (Malvey et al., 2006). Additionally, the diversity of online communities can engage students in different groups, enriching and deepening their understanding of community needs as well as their civic and professional responsibilities (Ahmad & Gul, 2023). Nevertheless, e-SL requires digital literacy and additional effort to sustain effective online communication in the absence of in-person interactions among stakeholders, including university students, teachers, community partners, and service targets (Bharath, 2020; Marcus et al., 2020). Malvey et al. (2006) noted that in e-SL, students may "likely miss out on the spontaneity and excitement of events by not being physically onsite" (p. 191), potentially impairing the positive effects on service providers and recipients.

While FTF-SL and e-SL are both grounded in the experiential learning philosophy, they may differ fundamentally in the social context in which the learning cycle is enacted. Social Presence Theory (Short et al., 1976) provides a critical lens for understanding this distinction. The theory posits that communication media vary in their capacity to convey socio-emotional cues (e.g., facial expressions, body language, tone of voice), a capacity defined as "social presence". Research in this area often focuses on a medium's ability to allow users to project themselves as "*real*" people and to develop interpersonal relationships (Lowenthal, 2010). High-social-presence media (e.g., face-to-face interaction) foster a stronger sense of co-presence and psychological connection, whereas low-social-presence media (e.g., early text-based online communication) may constrain socio-emotional exchange (Gunawardena, 1995). The level of social presence experienced by students is not merely a background feature but a pivotal factor influencing cognitive engagement, interaction, emotional investment, and ultimately, learning outcomes and course satisfaction (Lim, 2023; Lim et al., 2021).

In the context of online education, a key debate centres on whether technology can bridge this gap of social presence. Some researchers argue that, even with advanced videoconferencing tools, digital interfaces may still lack the nuanced, multimodal, and embodied interactivity of in-person interaction, creating a potential deficit in seamless nonverbal communication (Wut & Xu, 2021). Conversely, other scholars believe that social presence is not an inherent property of a medium but can be actively constructed through instructional design (Cui et al., 2013). Pedagogical strategies such as facilitating small-group collaborations, structuring reflective discussions, encouraging personal sharing, and employing multi-sensory content (e.g., audio/video briefings) have been shown to effectively cultivate a functional sense of community and presence in online courses, thereby promoting learning achievement and course satisfaction (Akyol et al., 2009; Arbaugh, 2008; Izmirli & Izmirli, 2019; Stankovska et al., 2021).

Recent empirical studies assessing the effectiveness and influence of e-SL suggest that it has similar beneficial effects among university students. For instance, Stanke et al. (2021) reported that after participating in e-SL, university students' generic skills, civic attitudes,

and values improved. Likewise, Compare and Albanesi (2022) concluded, based on a mixed-methods assessment, that e-SL participation enhanced students' civic responsibility, generic competence, teamwork spirit, and leadership skills. Several recent studies also found that e-SL is efficacious in fostering positive attributes, leadership skills, life meaning, and overall satisfaction with life among Chinese and Western undergraduate students (Ferdiansyah et al., 2022; X. Li et al., 2023; Lin et al., 2023; Shek et al., 2022; Zhu, Wu, et al., 2024; X. Zhu et al., 2022). However, research on e-SL remains less extensive than that on FTF-SL (Faulconer, 2021; Lin & Shek, 2021; Lin et al., 2023; Shek et al., 2022; Zhu, Wu, et al., 2024). More importantly, very few studies have directly compared the two modes. The limited existing comparative studies suggest similar improvements in general positive attributes, leadership skills, and subjective well-being among university students across modes during or before the pandemic (Lin & Shek, 2021; Wong & Lau, 2024). Nevertheless, whether online SL is as effective as the in-person format remains insufficiently examined, signalling a need for more direct comparisons.

Furthermore, to optimize SL across delivery modes, it is critical to comprehend the factors that influence students' achievement in SL. Grounded in the experiential learning cycle, students' engagement in relevant processes, such as their reflective and collaborative learning, may serve as essential predictors (Burch et al., 2019; Miller & Maellaro, 2016). Furthermore, according to the expectancy-value theory and social cognitive perspective on motivation, students' efforts and persistent investment in learning and course performance are primarily predicted by their beliefs about enjoyment in the learning process and values of the course, which can be generally reflected by students' overall satisfaction with the course (Doménech-Betoret et al., 2019; Lo et al., 2022). This aligns with the learning evaluation framework, which suggests that learners' subjective feelings facilitate learning efficiency and achievement (Kirkpatrick & Kirkpatrick, 2016). Thus, it can be argued that both learning- and feeling-related factors (e.g., reflective learning, collaborative learning, and course satisfaction) may serve as essential predictors of students' achievement in SL. Nevertheless, the predictive roles of these factors, particularly in direct comparative studies, remain underexplored.

The role of reflective learning

The SL pedagogy is a collaborative and reflective learning process that contains activities that require students to engage in open-minded reflection (Goff et al., 2020). Within the experiential learning cycle, reflection is recognized as a connective function that enables students to integrate direct learning experience with abstract concepts (Kolb, 1984; Kolb & Kolb, 2005). Rooted in this model, various discipline-oriented SL frameworks regard reflection as a critical component or stage (e.g., Petkus, 2000; Salam et al., 2019b; Whitley & Walsh, 2014). Indeed, it has long been contended that among the many features of effective SL, the combination of classroom instruction and service experience, along with consistent reflection on both, is key to achieving the academic goals of higher education (Mortari & Ubbiali, 2021). Dewey's perspective can be considered the philosophical foundation for understanding the role of reflection in SL. For him, "*active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends, constitutes reflective thinking*" (Dewey, 1933, p. 6). Two

principles emerge from the experiential learning cycle, as supported by Dewey's perspectives: first, experience itself is not inherently educational; second, reflective learning must be both continuous and structured. Students' reflections occur in at least two ways: individual introspection and collaborative reflection with course instructors, community partners, and peers engaged in SL. Through the continuous cycle of these processes, students develop cognitive abilities to identify, frame, and solve unstructured social problems (Wang et al., 2023). Subsequently, they connect concrete experiences with course-related theories and concepts. Through reflection, academic inquiry is anchored in a deeper understanding of societal issues, and new meaning is constructed in this iterative process (Colomer et al., 2020). Only then does experience become truly educational.

Other theoretical perspectives also support the essential role played by reflective learning in SL (Kawai, 2021). For example, Student Development Theory posits three fundamental dimensions of student growth, including cognitive, intrapersonal, and interpersonal development (Patton et al., 2016). In cognitive development, students transition from dualistic thinking (viewing knowledge as right or wrong) to accepting multiplicity, recognizing diverse perspectives and justifications. Reflective learning that explores service experiences in academically and personally meaningful ways challenges students' worldviews, prompting them to examine diverse viewpoints, thereby enhancing critical thinking skills (Eyler, 2011) and yielding psychological and intellectual benefits (Morris, 2020). In the intrapersonal and interpersonal dimensions, Student Development Theory posits that through sustained and meaningful reflection, students engage in inward and outward exploration, constructing an internal voice that serves as a foundation for committed action (Kawai, 2021). Thus, reflective activities are also considered an effective set of strategies for heightening self-awareness of individual and collective behavioural impacts (Jaakkola et al., 2022), which ultimately cultivates personal growth and the capacity for informed action (Glück & Weststrate, 2022). In the process of reflection, students critically examine their learning activities and community service experiences with reference to particular objectives for both the community and themselves (i.e., the reciprocity nature of SL). The process enables students to thoughtfully evaluate their strengths and weaknesses, as well as areas for future improvement, thereby facilitating the translation of service experiences into long-lasting educational outcomes and psychological benefits (Morris, 2020; Ogden & Claus, 2006). Reflective learning may therefore be the most important factor facilitating students' ability to derive benefits from their participation in SL. Despite the general theoretical consensus on the centrality of reflective learning in SL, surprisingly limited empirical evidence is available (van Goethem et al., 2014).

The role of collaborative learning

Collaborative learning is another integral part of SL. Multiple SL frameworks recognize collaborative learning as an effective methodological approach for achieving optimal educational outcomes (e.g., Roakes & Norris-Tirrell, 2000; Salam et al., 2019b; Voss et al., 2015). Specifically, students in SL projects typically work in groups to identify community needs, design and implement corresponding services, and collectively address on-site challenges (Zhu, Wu, et al., 2024). Effective collaboration enables individual group

members to co-construct service and learning objectives, share authority and responsibility, and mutually recognize and respect each other's abilities and contributions (Britt, 2014).

The efficacy of collaborative learning in SL is supported by established psychological and educational theories. For instance, from a constructivist perspective (Piaget, 1970), learning and individual development are conceived as active processes emerging through social interaction and environmental engagement. The Piagetian concepts of interaction and construction fundamentally inform collaborative learning practices. Through collaborative discourse, shared experiential engagement, and group reflection, students progressively resolve cognitive dissonance, develop adaptive self-regulation strategies, and co-construct meaningful understandings of self, others, and society (Brandenberger, 1998). Compared with competitive or individualistic learning models, collaborative approaches more effectively facilitate higher-order reasoning capacities, enabling students to comprehend complex information, engage in critical analysis and evaluation, synthesize knowledge, and apply solutions (Laal & Laal, 2012; Lu et al., 2021). Furthermore, collaborative learning promotes epistemological pluralism by encouraging students to critically examine their own experiences, cognitive frameworks, learning approaches, and professional practices as they engage with diverse perspectives (Lee & Yang, 2023). This proves particularly valuable when addressing multifaceted social problems, which inherently require dialogic, collaborative solutions.

Consequently, SL frameworks fundamentally conceptualize collaborative learning as a consensus-building mechanism that prioritizes collaborative achievement over individual competition (Salam et al., 2019b; Voss et al., 2015). This philosophy is grounded in the principle that collective engagement should inherently value and foreground the unique capabilities and contributions of all group members (Laal & Laal, 2012). Within collaborative interactions, students assume shared responsibility for their learning processes while actively acknowledging and respecting their peers' competencies and contributions. Pinto and Ramalho (2023) highlighted that SL projects provide practical opportunities for students to develop problem-solving abilities through teamwork. In such teamwork, students adapt to diverse situations collectively, build consensus, and resolve conflicts through collaboration rather than competition. Through this process, students can enhance their leadership competencies, sense of responsibility, communication and teamwork skills, and overall fulfilment (Aydin & Bozkurt, 2023; Chan et al., 2019; Hwang et al., 2019). Thus, collaborative learning may serve as a critical determinant of achieving key learning gains in SL, including the development of leadership skills and the promotion of overall well-being.

The role of course satisfaction

In addition to reflection and collaboration, subjective experiences and feelings may also contribute to students' learning achievement in SL (i.e., changes after completing SL). A key indicator of students' learning experience is their overall satisfaction. Student satisfaction reflects their cognitive appraisal of accomplishment and enjoyment, stemming from the successful fulfilment of their expectations within the learning context (Wong & Chapman, 2023; Yu, 2022). As Brandenberger (1998) argued, SL frameworks must account for the meaning-making processes through which students

interpret challenges encountered in both academic and service settings. Students' sense of achievement and satisfaction may signify the development of meaning and belief systems, echoing Parks's (1986) assertion that meaning making is central to cognitive and behavioural growth: "*To be human is to seek to understand the fitting connections between things. To be human is to desire relationship*" (p. 14). When students perceive SL activities as relevant, meaningful, appropriately challenging, and personally significant, they are more likely to invest greater effort and derive deeper learning (Li et al., 2016; Lo et al., 2022).

Complementarily, according to motivation and expectancy-value theories, satisfaction can enhance learners' active involvement, persistence, and willingness to exert efforts when encountering difficulties, ultimately leading to better performance and learning outcomes (Doménech-Betoret et al., 2019; Ilić et al., 2021). Empirically, satisfied students were more devoted and self-motivated in completing academic tasks in the mobile-assisted flipped classroom (Karaoğlan Yılmaz, 2022) and more engaged and persistent in the study programmes (Wilczewski et al., 2021). By fostering their desired and sustained learning behaviours, students' satisfaction is likely to be linked to better learning outcomes. Such an expectation aligns with Kirkpatrick's learning evaluation framework, suggesting that affective reactions (e.g., satisfaction) facilitate learning gains in attitudes, skills, and behaviours (Kirkpatrick & Kirkpatrick, 2016). For instance, a meta-analysis concluded that satisfaction is among the nine factors determining online learning outcomes in America, Asia, and Europe (Yu, 2022). More recent studies have also found that satisfaction directly influences students' academic performance and achievement (Almufarreh, 2023; Li & Ni, 2024). In the SL context, student satisfaction may motivate and catalyse the application of academic knowledge to community services, thereby fostering personal development and well-being. Indeed, the author and his collaborators reported significant positive associations between students' course satisfaction and improvements in attitude, skills, leadership, and well-being after taking various courses or training programmes, including SL (Zhu, Wu, et al., 2024). Nevertheless, there is a need to accumulate more empirical evidence from different samples to triangulate the findings.

The current study

This study aimed to fill the aforementioned gaps by investigating students' changes in one offshore SL course entitled "Service Leadership through Serving Children and Families with Special Needs (Xi'an)" ("Xi'an Service-Learning Course" hereafter) offered by The Hong Kong Polytechnic University using online mode in the 2021–2022 year and FTF mode in the 2022–2023 year.

The first research question we attempted to address was whether students' changes differed between the two SL modes. Using the pre-test-and-post-test design, we examined the differences in learning outcome indicators between students enrolled in the course under different delivery modes. Based on previous findings on FTF-SL and e-SL courses (Lin & Shek, 2021; Salam et al., 2019a), we anticipated positive changes in students' attributes, leadership qualities, and life satisfaction in both FTF-SL (Hypothesis 1a) and e-SL (Hypothesis 1b). Given the ongoing theoretical debate and the limited available direct empirical comparison between FTF-SL and e-SL, which suggested similar benefits of the two delivery modes (Lin & Shek, 2021; Wong & Lau, 2024), we also

expected that there would be no significant differences in students' changes regarding positive attributes, leadership qualities, and life satisfaction between the two modes (Hypothesis 1c).

The second research question we aimed to ask was whether students' changes would be predicted by reflective learning, collaborative learning, and course satisfaction. Based on previous studies (X. Li et al., 2023; Shek et al., 2022; Zhu, Wu, et al., 2024), we hypothesized significant positive predictions for these three factors (Hypotheses 2a–2c).

Method

A brief introduction of the "Xi'an service-learning course"

The "Xi'an Service-Learning Course" is a 3-credit SL course available to undergraduate students at The Hong Kong Polytechnic University. During the 2021–2022 academic year, the course was conducted online, with students attending lectures and workshops remotely and delivering their service plans via an online platform. In other words, physical travel to the service site was not required, and the primary school children received online lessons in their classrooms. Conversely, in the FTF mode during the 2022–2023 academic year, all activities were conducted on-site, with students physically present to implement their service plans.

Regardless of the delivery mode, the course maintains consistent objectives, curriculum content, teaching pedagogy, learning requirements, and assessment methods. The course spans two consecutive semesters (i.e., the second and the summer semesters), during which students engage in theoretical learning, service design, mock teaching, and service implementation. By incorporating both academic learning and service provision, this course aims to promote students' positive attributes (intrapersonal competencies, such as cognitive skills and resilience, and interpersonal competencies, such as social skills), leadership qualities (including self-leadership and collaboration with and service to others), and overall well-being.

Specifically, students allocate approximately 135 hours to theoretical study, service design, service implementation, and reflection. First, they spend 10 hours completing e-learning modules and corresponding tests on the basic concepts of SL. This requirement applies to all SL courses offered at the university. Second, students attend three 3-hour lectures that delve into the main factors contributing to effective services (e.g., intrapersonal qualities like resilience, interpersonal qualities like social skills, moral character, caring, and self-leadership), as well as the developmental characteristics and needs of underprivileged children and adolescents (e.g., migrant children). Typically, eight small groups of 5–6 students each (i.e., 40–48 students) attend lectures together.

Third, four small groups of students (i.e., 20–24 students) attend seven workshops together. In the first five workshops delivered before service provision, students learn about the needs of their service targets, core principles, and useful skills for designing and implementing services; discuss each small group's service plans; and have opportunities to demonstrate aspects of the services (i.e., mock teaching). The service targets in this course are Grade 3 children, many of whom are migrant children whose families have moved from villages to the city in search of improved employment opportunities. However, due to inadequate educational resources, limited social capital, and a

potentially ineffective familial environment, these children are considered vulnerable (Lin & Shek, 2021). Students are guided to develop group service plans to enhance children's learning motivation and promote their social and emotional development (e.g., emotional and communication skills). In early July, students collaborate to arrange a four-day summer camp at the elementary school to implement their service plans in groups. Specifically, each small group takes care of 25–30 children, provides multiple interactive activities covering four topics (i.e., daily English, interesting science, health, and personal development), and prepares the children to perform at the closing ceremony.

The last two workshops are conducted during and after the service provision phase, aiming to assist students in reflecting on and consolidating their service experiences. Finally, students are required to spend 55 hours on self-study activities (e.g., reading and revising service plans), service preparation, and post-service debriefing and reflection.

Participants and procedures

Data for this study were gathered from students registered in the online and FTF "Xi'an Service-Learning Course" during the academic years 2021–2022 and 2022–2023, respectively, at The Hong Kong Polytechnic University. The authors obtained ethical approval from the Institutional Review Board at their university.

University students were freely enrolled in the course based solely on their learning interests. There were no restrictions on any factors (gender, majors, or years of study) regarding course registration. A purposive sampling strategy was adopted in the present study. Specifically, all enrolled students were invited to complete a pre-test questionnaire voluntarily one week prior to the first lesson. Additionally, a post-test questionnaire was sent to students the day after the final lesson, and they were instructed to complete it within one week. Both the pre-test and post-test questionnaires assessed students' learning outcome variables, as measured by indicators such as service leadership qualities, positive youth development attributes, and life satisfaction. At the end of the last lesson, students were also asked to review and retrospectively report on their collaborative and reflective learning and course satisfaction based on their experiences during the subject period. These retrospective self-ratings served as predictors of the outcome variables measured in the post-test questionnaire administered within one week after the course concluded. Because some students added to or dropped from the course after the first lesson during the add/drop period, the dataset included data from only one assessment occasion. As students were freely enrolled, the sample included in the present study may not represent the student population at the university very well.

In the e-SL offered in 2021–2022, of the 87 enrolled students, 85 and 77 completed the pre-test and post-test, respectively, with 66 students matched (mean age: 19.39 ± 1.20 years; 62.12% female). In the FTF-SL offered in 2022–2023, 58 students were enrolled, of whom 54 and 53 completed the pre-test and post-test, respectively, leading to a matched sample of 49 students (mean age: 19.53 ± 1.39 years; 65.31% female). In both years, the majority of participants were in their first or second year of university study, which is reasonable, as most students enrol in one SL subject during the first two years of university and spend the later summers in internships.

Thus, the pre-test and post-test data of 115 students (mean age: 19.45 ± 1.28 years; 63.48% females) were matched (see Table 1). There were no significant differences

Table 1. Descriptions of the sample.

Variables		2021–2022 (Online)	2022–2023 (face-to-face)	Total	Comparison (2022 vs. 2023)
Pre-test (N)		85	54	139	
Age	Mean	19.46	19.56	19.50	$t = -0.44$
	SD	1.21	1.34	1.26	$p = 0.66$
Gender	Male (n, %)	30 (35.29%)	19 (35.19%)	49 (35.25%)	$\chi^2 = 0.00$,
	Female (n, %)	55 (64.71%)	35 (64.81%)	90 (64.75%)	$p = 1.00$
Year of Study	Year 1	25 (29.41%)	18 (33.33%)	43 (30.94%)	$\chi^2 = 4.99$,
	Year 2	50 (58.82%)	23 (42.59%)	73 (52.52%)	$p = 0.17$
	Year 3	9 (10.59%)	11 (20.37%)	20 (14.39%)	
	Year 4	1 (1.18%)	2 (2.70%)	3 (2.16%)	
Major	Social science	39 (45.88%)	38 (70.37%)	77 (55.40%)	$\chi^2 = 8.01$,
	Science	46 (54.12%)	16 (29.63%)	62 (44.60%)	$p = 0.005$
Post-test (N)		77	53	130	
Age	Mean	19.48	19.62	19.54	$t = -0.61$
	SD	1.25	1.39	1.31	$p = 0.27$
Gender	Male (n, %)	30 (38.96%)	18 (33.96%)	48 (36.92%)	$\chi^2 = 0.34$,
	Female (n, %)	47 (61.04%)	35 (66.04%)	82 (63.08%)	$p = 0.59$
Year of Study	Year 1	27 (35.06%)	20 (37.74%)	47 (36.15%)	$\chi^2 = 3.95$,
	Year 2	40 (51.95%)	20 (37.74%)	60 (46.15%)	$p = 0.27$
	Year 3	9 (11.69%)	11 (20.75%)	20 (15.38%)	
	Year 4	1 (1.30%)	2 (3.77%)	3 (2.31%)	
Major	Social science	35 (45.45%)	39 (73.58%)	74 (56.92%)	$\chi^2 = 10.13$,
	Science	42 (54.55%)	14 (26.42%)	56 (43.08%)	$p = 0.001$
Matched (N)		66	49	115	
Age	Mean	19.39	19.53	19.45	$t = -0.57$
	SD	1.20	1.39	1.28	$p = 0.29$
Gender	Male (n, %)	25 (37.88%)	17 (34.69%)	42 (36.52%)	$\chi^2 = 0.12$,
	Female (n, %)	41 (62.12%)	32 (65.31%)	73 (63.48%)	$p = 0.85$
Year of Study	Year 1	22 (33.33%)	18 (36.73%)	40 (34.78%)	$\chi^2 = 2.43$,
	Year 2	35 (53.03%)	20 (40.82%)	55 (47.83%)	$p = 0.49$
	Year 3	8 (12.12%)	9 (18.37%)	17 (14.78%)	
	Year 4	1 (1.52%)	2 (4.08%)	3 (2.61%)	
Major	Social science	28 (42.42%)	35 (71.43%)	63 (54.78%)	$\chi^2 = 9.55$,
	Science	38 (57.58%)	14 (28.57%)	52 (45.22%)	$p = 0.002$

between matched students across the two modes in age, gender, or year of study (see Table 1). However, more students from social science majors participated in the FTF-SL offered in the 2022–2023 academic year.

Previous studies have reported medium to large effect sizes for changes in various outcome measures upon participation in FTF or online SL courses (e.g., Lin & Shek, 2021). Based on a power analysis using G*Power, the required minimum sample size is 34 to detect a medium effect with 0.80 statistical power at the 0.05 significance level in a repeated-measures design with two assessment occasions. Thus, the sample size in this study is sufficient.

Measures

There were two sets of key measures. One set concerned learning outcome indicators, which reflected the course's intended learning outcomes, including general positive attributes, service leadership qualities, and well-being. The other covered predictors of students' learning achievement, including collaborative learning, reflective learning, and satisfaction with the course.

Positive youth development attributes

This study utilized the Chinese Positive Youth Development Scale (CPYDS), a 31-item brief version that has been extensively used in previous research to assess students' positive attributes at both the pre-test and post-test (X. Li et al., 2023; Shek et al., 2023). Previous research has supported the scales' reliability and validity (Zhu, Chu, et al., 2024). The scale consisted of ten subscales assessing ten PYD characteristics (e.g., cognitive competence, social competence, and self-efficacy). These constructs were further grouped into three PYD qualities: cognitive-behavioural competence (CBC) with nine items (e.g., "I try new ways to solve my problems"), positive identity (PI) with five items (e.g., "I am a person with self-confidence"), and general PYD qualities (GPYD) with 17 items (e.g., "When I face difficulties, I do not give up easily"). Participants rated their own PYD attributes on a six-point Likert scale from "1" ("strongly disagree") to "6" ("strongly agree"). We calculated composite scores for these three dimensions and a total PYD quality score, as four measures of positive attributes. These measures demonstrated good reliability, with Cronbach's αs above 0.84 in this research.

Service leadership qualities

The pre-test and post-test employed the 28-item Service Leadership Quality Scale (SLQS), which has been widely used in previous studies (Lin & Shek, 2021; Zhu & Shek, 2021). This scale assessed three qualities: self-leadership (5 items, e.g., "I understand the importance of self-development"), caring disposition (8 items, e.g., "I am sensitive to others' needs"), and character strength (15 items, e.g., "I place my interests after the interests of others"). A six-point scale from "1" ("strongly disagree") to "6" ("strongly agree") was used. Four measures of SLQ were computed: a composite score for each of the three dimensions and a total SLQ calculated as the average of all items. These measures demonstrated excellent reliability in this study, with Cronbach's αs greater than 0.87.

Life satisfaction

Similar to previous studies (Lin & Shek, 2021; Shek et al., 2023), this study employed the 5-item Chinese version of the "Satisfaction with Life Scale" (C-SWLS) to assess students' life satisfaction concerning their overall appraisal of life quality (e.g., "My life is very close to the one I desire"). Life satisfaction was assessed in both the pre-test and post-test. Participants completed Likert scale items ranging from "6" ("strongly agree") to "1" ("strongly disagree"). The scale demonstrated satisfactory reliability, with Cronbach's α values exceeding 0.88.

Collaborative learning

Students rated their own collaborative learning on a 6-item scale (e.g., "Collaborative learning in my group was effective in this course") developed by So and Brush (2008). All items were assessed using a five-point Likert reporting scale ("1 = strongly disagree, 5 = strongly agree"), where higher scores indicated higher levels of collaborative learning. Good reliability was indicated by the scale's Cronbach's α in this study, which was 0.93.

Reflective learning

Reflective learning was assessed by a 6-item scale developed by Xiao et al. (2014). An example item on the scale was "I liked to think about my actions to find alternative ways

of doing them". All items were rated on a five-point Likert scale ("1 = strongly disagree, 5 = strongly agree"). The reliability of the scale in this study was excellent, with a Cronbach's α of 0.91.

Satisfaction with the SL course

Overall satisfaction with the SL course was measured using three items: "Will you suggest your friends take this course?" "Will you participate in similar courses again in the future?" and "On the whole, are you satisfied with this course?" Higher scores on a five-point scale indicated greater overall satisfaction with the course. This study found this measure to be highly reliable, with a Cronbach's α of 0.87.

Data analysis

We tested students' pre-test – post-test changes across two delivery modes (i.e., online vs. FTF) using repeated-measures multivariate general linear modelling (RM-GLM) in IBM SPSS Statistics (Version 29.0). Within this framework, the dependent variables were the scores in three outcome measures: positive attributes, service leadership qualities, and life satisfaction. The independent variables were the within-participants factor (test time) and the between-participants factor (course mode). Initially, significant main effects or interactions between the independent variables were investigated. If there were any significant interactions between test time and course mode, separate RM-GLM analyses would be performed for each course mode and the entire sample to highlight the interaction effects. Because positive attributes and SLQ are multidimensional (i.e., with multiple outcome indicators), if the omnibus time effect in the multivariate RM-GLM was significant, follow-up univariate analyses with multiple comparisons would be conducted for each indicator. To reduce Type I errors inflated due to multiple comparisons, the Bonferroni correction in terms of dividing the original alpha value (0.05) by the number of comparisons (i.e., the number of indicators for positive attributes and SLQ, respectively) would be applied.

To further investigate the predictive effects of students' learning and course satisfaction on their achievement, multiple regression analyses were conducted with post-test total PYD quality, total SLQ, and life satisfaction as separate dependent variables and students' reflective learning, collaborative learning, and course satisfaction as individual predictors. In all models, age, gender, and respective pre-test scores were statistically controlled.

Results

Pre-test–post-test changes

Results of RM-GLM analyses on students' changes in outcome measures after completing the course are presented in Table 2. Results yielded a significant omnibus time effect (i.e., overall positive changes from pre-test to post-test) for positive attributes ($F = 6.43$, $p < 0.001$, $\eta^2 p = 0.15$), service leadership qualities ($F = 6.46$, $p < 0.001$, $\eta^2 p = 0.15$), and life satisfaction ($F = 13.25$, $p < 0.001$, $\eta^2 p = 0.11$) in multivariate analyses. Individual positive attributes and service leadership quality measures also showed positive changes after the

Table 2. Results of repeated-measures multivariate general linear model analyses on pre-test – post-test differences.

			Pre-test		Post-test			Time effect (Pre-test vs. post-test)		Course mode effect (online vs. face-to-face)		Interaction (Time × Course mode)	
Variable	Course mode	*n*	*M1*	*SD1*	*M2*	*SD2*	Mean difference (*M2* – *M1*)	*F*	η^2_p	*F*	η^2_p	*F*	η^2_p
Positive Attributes								6.43***	0.15	2.75*	0.07	0.22	0.01
CBC	Online	66	4.93	0.66	5.19	0.67	0.26	17.82***, a	0.14	7.78*, a	0.06	0.02	0.00
	Face-to-face	49	5.21	0.47	5.45	0.55	0.24						
PI	Online	66	4.80	0.82	5.06	0.86	0.26	14.15**, a	0.11	6.21	0.05	0.16	0.00
	Face-to-face	49	5.15	0.66	5.36	0.63	0.21						
GPYD	Online	66	4.86	0.58	5.07	0.58	0.20	12.56**, a	0.10	4.21	0.04	0.41	0.00
	Face-to-face	49	5.07	0.49	5.21	0.42	0.14						
TPYD	Online	66	4.87	0.62	5.10	0.62	0.23	18.31***, a	0.14	6.35*, a	0.05	0.23	0.00
	Face-to-face	49	5.13	0.47	5.31	0.45	0.19						
Service Leadership Qualities								6.46***	0.15	2.85*	0.07	2.63^	0.07
SL	Online	66	4.88	0.71	5.09	0.71	0.21	13.38***, a	0.11	7.27*, a	0.06	0.01	0.00
	Face-to-face	49	5.16	0.54	5.38	0.52	0.22						
CS	Online	66	4.87	0.58	4.99	0.62	0.12	18.07***, a	0.14	3.97	0.03	3.82	0.03
	Face-to-face	49	4.95	0.52	5.29	0.54	0.33						
CD	Online	66	5.12	0.63	5.27	0.68	0.16	9.65*, a	0.08	6.67*, a	0.06	0.01	0.00
	Face-to-face	49	5.37	0.50	5.54	0.52	0.17						
TSLQ	Online	66	4.95	0.59	5.12	0.62	0.17	17.35***, a	0.13	6.78*, a	0.06	0.61	0.01
	Face-to-face	49	5.16	0.47	5.40	0.50	0.24						
Life satisfaction	Online	66	4.55	0.85	4.68	0.94	0.13	13.25***	0.11	1.28	0.01	4.50*	0.04
	Face-to-face	49	4.53	0.93	5.02	0.79	0.49						

Note. CBC = Cognitive-behavioural competence; PI = Positive identity; GPYD = General positive youth development quality; TPYD = Total positive youth development quality; SL = Self-leadership; CS = Character strengths; CD = Caring disposition; TSLQ = Total service leadership quality [a] Adjusted Bonferroni alpha value = 0.013; ^$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Bonferroni adjustment ($Fs = 9.65–18.31$, $ps < 0.013$, $\eta^2p = 0.08–0.14$). An interesting finding was the significant main course effects in some of the positive attributes and service leadership quality measures (Fs in univariate analyses = 3.97–7.78, $ps < 0.013$, $\eta^2p = 0.03$–0.04), with self-perceived scores significantly lower among students taking the online course in the 2021–2022 year, although the effect sizes were not large. Furthermore, the interactions between testing time and course mode were marginally significant for service leadership qualities ($F = 2.63$, $p = 0.054$, $\eta^2p = 0.07$) and significant for life satisfaction ($F = 4.50$, $p < 0.05$, $\eta^2p = 0.04$).

Table 3 and Figure 1 present the results of separate RM-GLM analyses of individual samples from the two courses and of the entire sample. Most outcome measures in both individual samples showed significant positive improvements from pre-test to post-test. However, life satisfaction only showed a significant change in the FTF course ($F = 10.49$, $p < 0.01$, $\eta^2p = 0.18$), but not in the online course ($F = 1.88$, $p > 0.05$, $\eta^2p = 0.03$). Additionally, the effect size of the change in character strength as an indicator of SLQ was larger in the FTF course ($\eta^2p = 0.26$),

Table 3. Results of repeated-measures multivariate general linear model analyses on pre-test – post-test differences by course mode.

		Pre-test		Post-test			
Course mode	Variables	*Mean*	*SD*	*Mean*	*SD*	*F* value	η^2_p
2021–2022	Positive Attributes					3.98*	0.16
(Online, $n = 66$)	CBC	4.93	0.66	5.19	0.67	10.53$^{**, a}$	0.14
	PI	4.80	0.82	5.06	0.86	9.83$^{*, a}$	0.13
	GPYD	4.86	0.58	5.07	0.58	10.04$^{**, a}$	0.13
	TPYD	4.87	0.62	5.10	0.62	12.13$^{**, a}$	0.16
	Service Leadership qualities					2.45$^{\wedge}$	0.11
	Self-leadership	4.88	0.71	5.09	0.71	7.00$^{*, a}$	0.10
	Character strength	4.87	0.58	4.99	0.62	3.10	0.05
	Caring disposition	5.12	0.63	5.27	0.68	5.38	0.08
	Total service leadership	4.95	0.59	5.12	0.62	6.78$^{*, a}$	0.10
	Life Satisfaction	4.55	0.85	4.68	0.94	1.88	0.03
2022–2023	Positive Attributes					2.73$^{\wedge}$	0.15
(face-to-face, $n = 49$)	CBC	5.21	0.47	5.45	0.55	7.92$^{**, a}$	0.14
	PI	5.15	0.66	5.36	0.63	5.16	0.10
	GPYD	5.07	0.49	5.21	0.42	3.79	0.07
	TPYD	5.13	0.47	5.31	0.45	7.21$^{**, a}$	0.13
	Service Leadership qualities					6.07$^{**, a}$	0.28
	Self-leadership	5.16	0.54	5.38	0.52	6.75$^{*, a}$	0.12
	Character strength	4.95	0.52	5.29	0.54	16.68$^{***, a}$	0.26
	Caring disposition	5.37	0.50	5.54	0.52	4.40	0.08
	Total service leadership	5.16	0.47	5.40	0.50	10.48$^{**, a}$	0.18
	Life Satisfaction	4.53	0.93	5.02	0.79	10.49**	0.18
Combined	Positive Attributes					6.77***	0.15
($n = 115$)	CBC	5.05	0.60	5.30	0.63	18.57$^{***, a}$	0.14
	PI	4.95	0.77	5.19	0.78	15.04$^{***, a}$	0.12
	GPYD	4.95	0.55	5.13	0.52	13.60$^{**, a}$	0.11
	TPYD	4.98	0.57	5.19	0.57	19.47$^{***, a}$	0.15
	Service Leadership qualities					5.95***	0.14
	Self-leadership	5.00	0.66	5.21	0.65	13.71$^{**, a}$	0.11
	Character strength	4.91	0.55	5.12	0.60	15.74$^{***, a}$	0.12
	Caring disposition	5.22	0.59	5.39	0.63	9.86$^{**, a}$	0.08
	Total service leadership	5.04	0.63	5.24	0.55	16.84$^{***, a}$	0.13
	Life Satisfaction	4.54	0.88	4.82	0.89	10.97**	0.09

Note. CBC = Cognitive-behavioural competence; PI = Positive identity; GPYD = General positive youth development quality; TPYD = Total positive youth development quality; [a] Adjusted Bonferroni alpha value = 0.013; $^{\wedge}$ $p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

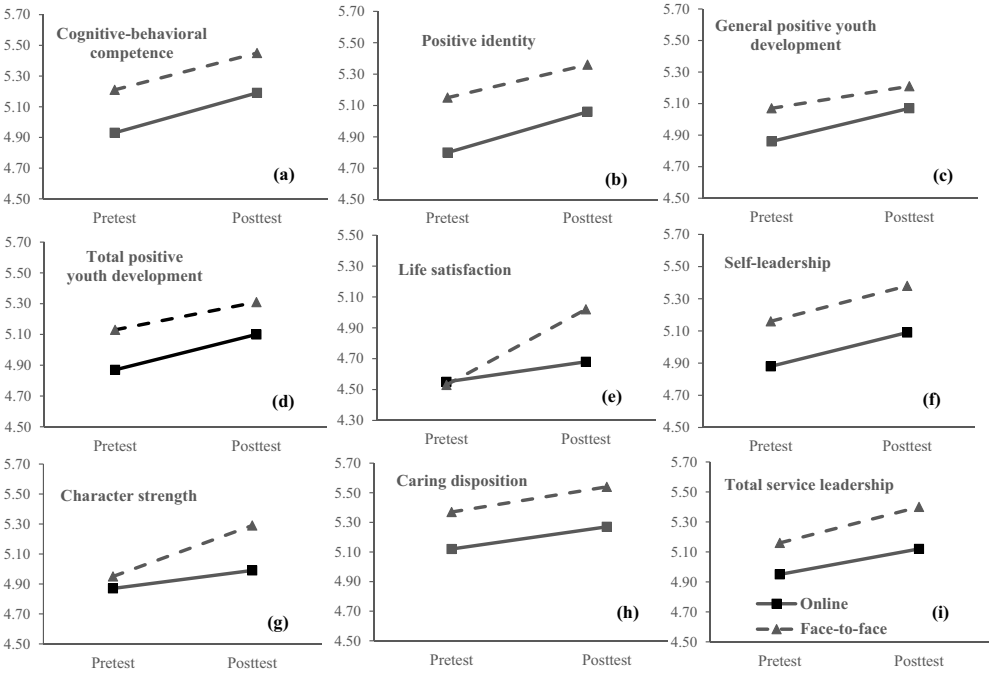

Figure 1. Interaction effects between time (pretest vs. posttest) and course mode (2022 online vs. 2023 face-to-face) on positive youth development attributes (a: cognitive-behavioral competence; b: positive identity; c: general positive youth development; d: total positive youth development), life satisfaction (e), and service leadership qualities (f: self-leadership; g: character strength; h: caring disposition; i: total service leadership).

but small and not significant ($\eta^2 p = 0.05$) in the online course after the Bonferroni adjustment, following Cohen et al.'s (2003) recommendations for the effect size magnitude.

Predictors of students' achievement

Table 4 summarizes regression analyses examining the predictive effects of students' learning and course satisfaction on their achievement in the course. After controlling for age, gender, and pre-test total PYD quality scores, post-test PYD quality scores were significantly predicted by reflective learning ($\beta = 0.51$, $p < 0.001$, Cohen's $f^2 = 0.53$), collaborative learning ($\beta = 0.55$, $p < 0.001$, Cohen's $f^2 = 0.62$), and overall course satisfaction ($\beta = 0.49$, $p < 0.001$, Cohen's $f^2 = 0.48$) in the respective regression models. Each predictor explained 22%, 25%, and 20% of the variance of the post-test total PYD quality, respectively. Similar findings emerged for SLQ and life satisfaction, with weaker effect sizes for life satisfaction (Cohen's $f^2 = 0.15$–0.20) compared to the other two indicators (Cohen's $f^2 = 0.46$–0.63).

Table 4. Results of regression analyses on the predictive effects of students' learning and satisfaction on outcomes.

Outcome	Model	Predictors	*B*	95% confidence interval		*SE*	*Beta*	Cohen's f^2	*F* change	R^2 change
				Lower	*Upper*					
TPYD	1	Age	−0.05	−0.12	0.02	0.03	−0.11	0.02		
		Gender	−0.05	−0.23	0.13	0.09	−0.05	0.00		
		Pre-test TPYD	0.60	0.45	0.76	0.08	0.61***	0.56	20.51***	0.36
	2	Reflective learning	0.54	0.40	0.68	0.07	0.51***	0.53	57.98***	0.22
	3	Collaborative learning	0.60	0.45	0.74	0.07	0.55***	0.62	67.43***	0.25
	4	Satisfaction	0.35	0.25	0.45	0.05	0.49***	0.48	50.66***	0.20
TSLQ	1	Age	−0.04	−0.11	0.03	0.04	−0.09	0.01		
		Gender	−0.04	−0.22	0.14	0.09	−0.03	0.00		
		Pre-test TSLQ	0.65	0.49	0.81	0.08	0.62***	0.58	21.17***	0.37
	2	Reflective learning	0.53	0.39	0.68	0.07	0.50***	0.48	52.86***	0.21
	3	Collaborative learning	0.60	0.46	0.75	0.07	0.54***	0.63	69.07***	0.25
	4	Satisfaction	0.34	0.25	0.44	0.05	0.48***	0.46	48.58***	0.19
LS	1	Age	−0.03	−0.14	0.09	0.06	−0.04	0.00		
		Gender	−0.24	−0.55	0.06	0.15	−0.13	0.02		
		Pre-test LS	0.48	0.31	0.64	0.09	0.47***	0.29	11.60***	0.24
	2	Reflective learning	0.54	0.28	0.79	0.13	0.33***	0.15	16.82***	0.10
	3	Collaborative learning	0.63	0.36	0.90	0.14	0.37***	0.20	21.59***	0.13
	4	Satisfaction	0.39	0.21	0.57	0.09	0.35***	0.18	18.76***	0.11

Note. For each outcome measure, age, gender, and pre-test score of the measure were controlled in Models 2–4 testing unique predictions of reflective learning, collaborative learning, and student satisfaction with the course, respectively. TPYD = Total positive youth development quality; TSLQ = Total service leadership quality; LS = Life satisfaction. ***$p < 0.001$.

Discussion

Service-Learning (SL) is an educational paradigm that has gained prominence in recent years in many countries beyond North America, where it originated. However, in China, its development is relatively recent, and most existing studies have focused on conceptual and practical discussion of its integration into established educational practices in fields such as Social Work and Medicine (Hong, Wan, et al., 2024; Ma et al., 2018). As a result, compared with extensive research on SL's impacts on students in the West, related investigations in China are grossly lacking. Due to the COVID-19 pandemic, universities worldwide have had to adopt online or hybrid teaching models on a large scale. In light of this paradigm shift, it is imperative to evaluate the comparative effectiveness of online SL (e-SL) initiatives and traditional face-to-face SL (FTF-SL) in fostering student development. However, there is currently insufficient evidence in this field (Zhu, Wu, et al., 2024). Further investigation is also needed to identify factors that may affect student achievement in SL.

Different from most previous studies, including those conducted in Chinese contexts, that focused on either FTF-SL or e-SL (e.g., Compare & Albanesi, 2022, 2023; Hong, Chen, et al., 2024; Zhu, Wu, et al., 2024), the present study contributes to the SL literature by directly comparing students' changes in several outcome measures after taking an SL course delivered in FTF versus online. The present findings are thus more robust in revealing which approach is more effective in enhancing students' achievement. In

addition, this study examined two learning-related factors (collaborative learning and reflective learning) and one subjective evaluation factor (i.e., course satisfaction) as predictors of students' learning achievement, which have not been examined in previous SL studies, particularly in Chinese contexts. Such an initiative sheds light on how to enhance the positive impacts of SL on students and improve SL implementation.

Student learning achievement in e-SL versus in FTF-SL

Both e-SL and FTF-SL effectively facilitate student development, particularly in enhancing positive attributes and cultivating service leadership qualities. These findings reaffirm the value of SL as an experiential pedagogy in higher education for nurturing students' personal growth and leadership abilities, irrespective of delivery modes (Lin et al., 2023; Shek et al., 2022; Zhu, Wu, et al., 2024). Unlike conventional teaching that focuses on theoretical knowledge, SL courses offer immersive and hands-on learning experiences in service provision, thereby enhancing students' teamwork, leadership, communication, critical thinking, autonomy, and problem-solving skills (Salam et al., 2019a). By linking theoretical concepts to real-world challenges, SL bridges the gap between knowledge acquisition and application, allowing students to unleash their potential, foster holistic development, and bolster well-being (Anderson et al., 2019; Goff et al., 2020; Zhu, Wu, et al., 2024). While e-SL students may not experience the same level of spontaneity and excitement as those engaged in on-site service activities (Waldner et al., 2012), advancements in videoconferencing and digital collaboration tools have rendered online learning and service provision both feasible and effective, especially for digitally native youth (Lin et al., 2023).

Despite the above results, traditional FTF-SL seems to outperform e-SL in enhancing students' leadership qualities and life satisfaction to some extent in the present study. This finding aligns with previous observations that certain qualities, such as civic responsibility, interpersonal skills, empathy, and problem-solving abilities, may develop better in FTF learning environments compared to virtual modes (Neamtu & Faludi, 2021; Schwehm et al., 2017). Such differences could be interpreted through the lens of Social Presence Theory, which posits that communication media vary in their capacity to transmit socio-emotional cues (e.g., nonverbal signals, immediate feedback, environmental context) that shape users' perceptions of "co-presence" and psychological connection (Short et al., 1976). As a high-social-presence medium, FTF-SL's fundamental advantage lies in its ability to enable the multisensory, synchronous integration of cues (Wut & Xu, 2021). The richer sensory and contextual feedback available in FTF-SL appears to facilitate deeper socio-cognitive engagement. In our study, the service recipients were disadvantaged elementary school students who required more care. This specific service context likely necessitated greater psychosocial investment from students, including greater emotional sensitivity and responses, specialized communication approaches, and strategic adaptation of interaction modalities. Such processes appear to be more readily supported in physical settings. During in-person service interactions, students do not merely process verbal content, but also simultaneously receive and interpret a rich stream of contextual information from micro-expressions, body language, vocal nuances, and the shared physical environment, which likely facilitates key psychological processes (e.g., stronger emotional

attunement and empathic responses) that underlie students' growth and positive changes. This may be the core mechanism underlying the more pronounced improvements in life satisfaction and leadership qualities in FTF-SL.

This perspective is further supported by the fact that in-person interactions can more effectively facilitate the practical application of leadership principles in real-world settings. For instance, in-person communication has been found to exert a greater impact on students' engagement in learning than online interactions (Spring et al., 2024). Physical co-presence and face-to-face interaction in community settings foster a stronger sense of connection, enabling students to more directly witness the impact of their actions on service recipients and to receive positive feedback from community partners, thereby enhancing efficacy and fulfilment and leading to higher satisfaction with oneself (Wong & Lau, 2024). Conversely, e-SL relying on digital platforms, while flexible, can present limitations regarding social interaction, communication, and collaborative potential, failing to replicate the openness, spontaneity, and vitality characteristic of face-to-face exchanges (Eklund & Isotalus, 2024).

Consequently, it is reasonable to posit that FTF-SL may afford students greater decision-making autonomy and adaptability in responding to environmental cues during service implementation, thereby strengthening perceived competence and leadership development. The physical co-presence in FTF-SL may generate immediate, embodied feedback that reinforces students' sense of personal efficacy and the acquisition of leadership skills. This effect may be particularly pronounced given leadership's inherent dependence on rich social interactions (DeRue & Ashford, 2010). In other words, environments characterized by high social presence may create more authentic interactive contexts, thereby enhancing the perceived authenticity and consistency of feedback when students apply learned strategies in direct, experiential interactions with child service recipients. This interpretation aligns with research findings linking social presence to outcomes such as learner autonomy, interaction, collaboration, and course satisfaction (Stankovska et al., 2021).

Therefore, this study holds that the second critical psychological process illuminated by Social Presence Theory involves the aforementioned immediate, embodied feedback cycle. When students were able to flexibly apply the theories and strategies derived from the present SL course in actual (directly experiential) interactions with service recipients and observed responses consistent with what they expected, their sense of self-efficacy and positive perception of learning outcomes may be magnified, thereby improving their life satisfaction. These deeper social interactions and multisensory synchronous integrations, supported by high social presence in FTF-SL, collectively create a psychologically richer learning experience, one that digital platforms may still struggle to replicate with comparable effectiveness.

Furthermore, enhanced life satisfaction and service leadership qualities may reinforce one another, leading to greater learning gains in both domains, as recent research has observed reciprocal effects between life satisfaction and leadership attributes (Shek et al., 2023). This conjecture echoes the emphasis on the paramount role of physical interaction in students' learning progress, with university students expressing that "the advantages of physical interaction are irreplaceable by anything else" (Nikolopoulou, 2022, p. 4). Thus, the advantage of FTF-SL is not merely due to its "offline" format but stems from its high social presence, which more effectively

supports learning goals that depend on rich socio-emotional integration and immediate feedback. This aligns with the core proposition of the Social Presence Theory.

Nevertheless, other studies reported minimal differences between FTF-SL and e-SL across various learning and developmental outcomes, such as leadership skills, communication, and problem-solving skills (Lin & Shek, 2021; Riaji et al., 2024; Wong & Lau, 2024), which is a finding corroborated by the similar improvements in generic positive attributes observed in both e-SL and FTF-SL in this study. Social Presence Theory also highlights that social presence is not a static, inherent property of a medium but can be actively constructed through intentional instructional design. Although e-SL originates as a "leaner" medium with fewer natural social cues, well-structured online learning activities (e.g., collaborative group tasks, guided reflection) and indirect community service engagements may compensate for this limitation. In these structured environments, students have opportunities to meaningfully engage in multi-stakeholder projects, address practical problems, and apply academic knowledge, thereby achieving substantive progress across multiple dimensions. By enhancing task structure, fostering deep cognitive engagement, and establishing clear collaborative norms, e-SL can also cultivate a functional social presence in the online environment. This constructed presence enables e-SL to effectively support learning goals that emphasize cognitive restructuring, planned collaboration, and reflective internalization, such as cognitive-behavioural competencies, social responsibility, and positive self-identity. This explains why, in some studies, e-SL demonstrates comparable or even slightly superior outcomes, particularly when leveraging specific pedagogical strengths. For example, Wong and Lau's (2024) analyses of qualitative data collected from reflective journals, project reports, and qualitative comments suggest that desirable practices, such as good preparation and commitment of teachers, students, and community partners as well as students' constant reflection may turn the challenges posed by the online environment in e-SL into extra learning opportunities, which would make e-SL equally effective as, or even slightly outperform, traditional FTF-SL.

Indeed, research on online learning consistently underscores the pivotal role of instructional design in fostering social presence. Strategies such as facilitating small-group discussions, encouraging personal sharing, providing detailed feedback, and employing multimedia content have been shown to effectively build appropriate social presence, thereby promoting engagement and satisfaction (Izmirli & Izmirli, 2019; Lim et al., 2021; Stankovska et al., 2021). These pedagogical interventions could partially offset the reduced social presence in e-SL, helping students develop sufficient psychological investment even in "leaner" media environments. By applying Social Presence Theory, this study moves beyond simply documenting differences between the two modes; it posits that the comparative effectiveness of SL delivery modes may be linked to the degree to which specific learning outcomes depend on high-fidelity, synchronous socio-emotional cues and immediate feedback. This theoretical insight not only explains the observed patterns but also provides a valuable lens for predicting and interpreting similarities and differences across future studies. Given the limited direct comparisons between e-SL and FTF-SL, and the inconclusive nature of existing findings, further research is needed to empirically test and refine these propositions, particularly from a social presence perspective.

The predictive effect of reflective learning on student achievement

As expected, reflective learning and collaborative learning significantly contributed to students' learning attainment across all measures. These findings align with other studies highlighting the advantages of reflection and collaboration in student learning (Chamdani et al., 2022; Chan et al., 2019). Moreover, they empirically support the theoretical notion that both reflection and collaboration are essential components of SL (Britt, 2014; Goff et al., 2020).

Our findings contribute to the current body of knowledge in three ways. First, the study demonstrates that reflective learning serves as a predictive factor for the enhancement of both psychosocial competencies and service leadership qualities, supporting that reflection in SL plays a significant role in bridging the gap between practical experiences in community services and academic learning, fostering students' more profound understanding of themselves, others, and the community. It facilitates skill improvement, enhances self-fulfilment, and contributes to self-awareness (Lorenzo Moledo et al., 2021). Through reflective learning, students consolidate SL experiences, critically assess advantages and limitations, identify learning gaps and developmental needs, and generate insights for future refinement and improvement (Wu & Crocco, 2019).

Second, this study highlights the role of structured reflection, which is emphasized in Kolb's experiential learning cycle. In this study, students were instructed to engage in multiple forms of introspective exercises (e.g., writing reflective journals and participating in reflective debriefing sessions on service provision) throughout the course. Effective engagement in reflective learning allowed students to translate practice into knowledge acquisition and skill development, fostering favourable attributes, leadership competence, and well-being (Morris, 2020). This finding underscores the importance of reflective learning, which is not strongly emphasized in Chinese higher education. In response, some Chinese university educators similarly emphasize the need to focus on structured reflective activities, designing students' reflective learning and activities in SL courses through two components: reflection on personal growth; reflection on the effectiveness of their professional service, with these two considered interdependent (Dai, 2022).

Third, this study demonstrates that reflective learning promotes university students' core PYD qualities, such as positive identity, and enhances their life satisfaction. A plausible interpretation is that, as students established interpersonal relationships with these vulnerable migrant children (service recipients), students' empathy, moral cognition, and care might have been cultivated in this process. This was likely to prompt them to engage in continuous reflective self-exploration, echoing the experiential learning cycle's core principle of "learning by doing". In this process, students might have deeply reflected on their prior perspectives, examined their beliefs, values, and life purposes, and thereby established life goals and future orientations, thereby increasing life satisfaction (Zeng et al., 2022). From this perspective, the study also indirectly supports SL's potential in promoting moral and civic cognitive learning, as well as moral sensitivity and motivational action (Li et al., 2019; Ma et al., 2017), since positive identity is associated with civic awareness and moral commitment (Cui et al., 2021).

The predictive effect of collaborative learning on student achievement

Similarly, collaborative learning experiences have been found to significantly enhance students' motivation, self-confidence, and sense of responsibility, thereby fostering the development of personal qualities and leadership skills (Dunbar et al., 2016; Qureshi et al., 2023). This study contributes to the literature by elucidating the significance of collaborative learning in SL from two key perspectives. First, from a competency-development standpoint, collaborative learning in SL is an effective pedagogical approach for enhancing participants' psychosocial competencies (e.g., cognitive and social competence) and service leadership qualities. In the present SL course under investigation, students worked in small groups to identify and develop strategies to address service recipients' needs. Through collaborative implementation of service plans and collective resolution of team disagreements and service challenges, students engaged in a comprehensive collaborative process that effectively constitutes a dynamic experiential learning cycle as proposed by Kolb (1984). This cyclical process begins with students gaining concrete experience through hands-on service activities, followed by reflective observation during team communication and problem-solving. By integrating multicultural perspectives and resolving cognitive conflicts, students achieve abstract conceptualization and develop more effective communication and leadership strategies. Finally, through continuous adjustment and improvement of service plans and leadership behaviours, students engage in active experimentation. This progressively advancing learning process in authentic contexts may not only strengthen students' cognitive and social competencies but also enhance their self-awareness and self-regulation, thereby promoting comprehensive development of service leadership. Moreover, when confronted with the vulnerabilities of migrant children, team members were required to collectively navigate emotional resonance and foster interpersonal connections. Such social interactions might have facilitated the cultivation of character strengths such as responsibility.

Second, regarding psychological growth, this study provides empirical support for the role of collaborative learning in SL in enhancing life satisfaction. Particularly when addressing complex social issues, collaborative learning establishes a platform for dialogue and emotional support, enabling group members to jointly overcome service-related challenges and maintain a sense of efficacy through cooperative problem-solving. This process was likely to deepen team cohesion and interpersonal connectedness, thereby contributing to increased life satisfaction. Correspondingly, scholars have advocated that active collaborative learning fosters a positive learning environment characterized by knowledge sharing, self-reflection, collective effort, and team spirit, all of which are conducive to students' learning performance and achievement (Qureshi et al., 2023). As such, in the current study, the collaborative learning approach made each group member a co-constructor of group success (Britt, 2014). Collaborative learning in SL provides students with valuable opportunities to practice self-leadership, experience peer influence, and develop teamwork skills, thereby enhancing their competence, skills (e.g., caring, emotional competence, self-management, resilience, problem-solving, and sense of self-efficacy), and well-being (Dunbar et al., 2016; Markowski et al., 2021). Consequently, the unique social and interactive nature of collaborative learning may create a transformative opportunity in which individual growth becomes observable and can be

reinforced through collective developmental processes. Given that the Chinese education system is highly competitive and discourages collaboration among learners, these findings suggest that SL is a beneficial vehicle for promoting collaborative learning among students. The strong preference for collaborative learning observed among Chinese students in previous studies (Xue & Lingling, 2018; Zhang, 2006) further substantiates the cultural adaptability of this instructional method. This alignment between the emphasis on cooperation and collectivist values in traditional Chinese culture and Chinese students' learning predispositions suggests particular promise for implementing SL programmes in Chinese higher education settings, particularly through collaborative learning approaches.

The predictive effect of course satisfaction on student achievement

The significant predictive effects of students' satisfaction with the SL course on their learning achievement align with previous findings from various courses, including leadership training, youth development programmes, and SL in different disciplines (Almufarreh, 2023; Li & Ni, 2024; Shek et al., 2023). Student satisfaction has been widely recognized as not only an essential metric to assess the quality and effectiveness of education services students receive in higher education but also a requirement for the attainment of important learning outcomes such as learning motivation, academic performance, and retention (Doménech-Betoret et al., 2019; Li & Ni, 2024; Wong & Chapman, 2023). The present findings provide empirical evidence for such a conclusion in the SL context and highlight the importance of enhancing students' positive evaluations in learning settings, which signifies successful teaching and learning characterized by more persistence and greater engagement (Doménech-Betoret et al., 2019; Ilić et al., 2021). The associations between student satisfaction and learning achievements in this study also provide empirical evidence for Kirkpatrick's evaluation model, establishing links between learners' evaluative reactions and outcomes at different levels (Kirkpatrick & Kirkpatrick, 2016). Furthermore, the positive predictive relationships between course satisfaction and improvements in PYD attributes, service leadership qualities, and life satisfaction suggest that course satisfaction may serve not merely as an evaluative metric but as a visible indicator of deeper cognitive-affective processes through which participants constructed personal meaning from their SL experiences. The observed association between course satisfaction and achievement among participants may reflect their attribution of meaning to their success. Additionally, through relational experiences, they reconfigured their self-understanding (e.g., recognizing leadership skills through mentoring migrant children), developed coherent narratives, and linked actions to social impact. These findings also offer practical insights. Designing structured reflections that prompt targeting meaning-making processes could be beneficial, as it allows students to consciously articulate their evolving understanding.

Nevertheless, given the inconclusive findings in prior research, particularly regarding the relationship between student satisfaction and knowledge acquisition (Ebner & Gegenfurtner, 2019), student satisfaction may be more conducive to learning gains in certain aspects (Lin & Shek, 2021). In fact, the present results also indicate that both course satisfaction and the other two learning-related predictors may be more closely related to students' improvement in generic skills and leadership qualities (effect sizes ranged

between 0.46 and 0.63) in comparison to life satisfaction as an indicator of well-being (effect sizes ranged between 0.33 and 3.37). This is not surprising as skill improvement was treated as a more direct and immediate learning outcome resulting from effective teaching and learning, whereas well-being enhancement may take longer to achieve. Moreover, while student satisfaction was usually assessed as a global measure of students' overall appraisal of their learning experience (e.g., Almufarreh, 2023; Li & Ni, 2024; Wilczewski et al., 2021), it can also encompass different dimensions, such as satisfaction with course design, teacher performance, and interactions, which may differently associate with learning outcomes (Lin et al., 2023; Zhu, Wu, et al., 2024). For instance, satisfaction with course content tended to be more strongly associated with learning achievement than satisfaction with teacher performance (Zhu, Wu, et al., 2024). This possibility warrants more nuanced investigations. Student satisfaction is both an outcome of a rewarding learning process and a requirement for successful learning (Doménech-Betoret et al., 2019). Thus, students' greater learning gains may also lead to higher course satisfaction (Lin et al., 2023), indicating reciprocal relationships between learning achievement and course satisfaction that warrant further research. Taken together, in-depth and meticulous longitudinal research is required to provide a comprehensive understanding of the relationship between overall student satisfaction (including its sub-dimensions) and learning achievement.

Practical implications

This study addresses a research gap by conducting a focused comparison of learning outcomes between FTF-SL and its online counterpart, i.e., e-SL. It provides empirical support for the comparable effectiveness of both modes, demonstrating that university students exhibit significant positive changes in key learning outcomes (e.g., positive attributes, service leadership qualities, and life satisfaction) through collaborative and reflective processes, regardless of the delivery mode.

The findings have practical implications, particularly for the evolving scholarship on hybrid learning. First, the positive changes among students engaged in e-SL or FTF-SL suggest that educators and researchers can promote SL in higher education as an effective pedagogy that bridges theoretical knowledge and practical application, thereby facilitating students' self-improvement through SL experiences. For example, SL can be employed in leadership training programmes and youth development initiatives.

Second, the evidence for the overall effectiveness of both modes could empower educators and institutions to make strategic, context-sensitive choices. FTF-SL remains preferable in the post-pandemic era due to its effectiveness in fostering in-person communication and its superior performance in supporting students' leadership development and holistic well-being. Meanwhile, well-designed e-SL presents an efficient, cost-effective, and scalable option for programmes seeking to develop students' generic skills and cognitive competencies, particularly when serving remote or dispersed communities. Ultimately, offering SL courses in different delivery modes can provide students with options aligned with their learning needs and circumstances, thereby optimizing their learning experiences and outcomes.

Third, this study highlights the importance of thoughtful curriculum and pedagogical design in facilitating students' reflective and collaborative learning, as well as their

satisfaction with learning, all of which are essential for achieving desired learning outcomes. For e-SL, educators should proactively "construct" social presence to compensate for the medium's natural constraints. This involves implementing meticulous design, such as defining clear group roles, embedding structured reflection points, and leveraging multimedia to enhance facilitator immediacy. The consensus is that a well-designed instructional process that thoughtfully integrates technology, teacher facilitation skills, and student characteristics is essential for coordinating the effectiveness and efficiency of social presence in online environments. For FTF-SL, it is necessary to fully leverage its high social presence advantage by designing service tasks that require complex interpersonal coordination, real-time nonverbal feedback, and emotional resonance, thereby maximizing the unique affordances of physical co-presence.

Last, within the competitive landscape of Chinese education, which has traditionally undervalued collaboration, SL courses emerge as a vital "social laboratory". This study supports their practical utility in deliberately cultivating collaborative competencies and reflective habits through structured tasks. By providing a proven avenue to foster the leadership and civic attributes required in the future society, SL addresses a critical gap in traditional Chinese curricula. Our findings offer evidence-based guidance for local educators seeking to implement this high-impact practice effectively, thereby contributing to the regional understanding of experiential learning pedagogies.

Limitations and future directions

Although this study offers theoretical and practical insights, it is crucial to recognize its limitations. First, the findings may be specific to the context and sample of university students, so caution is needed when extrapolating results to other populations or educational settings. Future research would benefit from using a more representative sample and collecting data from multiple SL courses across universities and regions. For instance, replication studies could be conducted across populations with varying educational backgrounds (e.g., high school students, undergraduate students, graduate students, and vocational college students) to examine the generalizability of our findings across multiple age groups and educational contexts.

Second, self-report measures may introduce response bias and social desirability effects. Additionally, the voluntary participation and free enrolment in the present study may introduce self-selection bias, limiting the sample's representativeness. For example, students who were enrolled likely held pre-existing positive perceptions of the SL course, which may have inflated self-reported outcomes (e.g., through social desirability or heightened expectations). Future research should incorporate diverse assessment methods, such as observational data or peer evaluations, to shed more light on students' development in SL. Meanwhile, under the premise of voluntary participation, additional measures could be implemented to mitigate or balance biases caused by prior perceptions and attitudes. To address this, future studies could incorporate pre-experiment questionnaires to quantify students' initial motivations or introduce multiple measurement points (pre-, mid-, and post-course) to disentangle the respective contributions of "initial interest" and "course intervention" to the outcomes.

Third, the close timing between the measurement of predictors (assessed during the final class session) and outcomes (measured within one week after course completion)

represents another limitation. While not entirely simultaneous, this brief interval may still constrain causal interpretation. Future research would benefit from incorporating mid-course assessment points to better establish temporal precedence and capture developmental dynamics.

Fourth, the absence of control groups in the one-group pre-test-post-test design limits interpretation, as alternative explanations such as maturation and test effects cannot be excluded entirely. Further research should include control-group students who do not participate in any SL projects.

Fifth, although the study identified predictors of learning achievement, establishing causality and understanding underlying mechanisms requires further longitudinal investigations. In addition, short-term SL intervention may not capture sustained developmental trajectories. Longitudinal studies are needed to assess whether cognitive or psychosocial gains persist beyond immediate post-course evaluations.

Finally, other ecological factors may also affect the findings. Addressing these limitations and expanding future research will enhance understanding of the benefits of SL and inform decisions to improve students' educational experiences and learning outcomes.

Conclusion

In summary, this study supports the positive effects of SL, including FTF-SL and e-SL, on students' development, indicated by improvement in generic positive attributes (e.g., emotional competence and cognitive competence), leadership skills (e.g., self-leadership), and well-being (i.e., life satisfaction). Comparing delivery modes highlights the influence of course format on effectiveness. Designing and implementing SL courses should consider the unique benefits and limitations of each approach. Additionally, the significant predictive effects of reflective learning, collaborative learning, and course satisfaction on students' learning achievement provide valuable insights for educators and course designers to improve SL effectiveness by optimizing instructional strategies and creating nurturing learning environments, which would facilitate students' engagement in essential learning activities and foster satisfaction with the course.

Author contributions

CRediT: **Xiaoqin Zhu:** Conceptualization, Formal analysis, Methodology, Supervision, Writing – review & editing; **Yiting Tang:** Writing – review & editing; **Xue Wu:** Writing – original draft; **Yunpeng Bai:** Writing – original draft; **Daniel T. L. Shek:** Funding acquisition, Supervision, Writing – review & editing.

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Data availability statement

Data will be made available on request.

Informed consent

Informed consent was obtained from all participants involved in the study.

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