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Zhengping Liow
Lecturer/PhD-student
Singapore Polytechnic
National University of Singapore
liow_zhengping@sp.edu.sg

Students' public success and private breakdown?

Exploring the relationships between social support, anxiety, and academic performance

ABSTRACT
Design literacy becomes more essential to creating a collaborative and inclusive society. Nonetheless, students were more anxious and exhibited lower performance when design studio tutors employed the conventional master-apprentice pedagogy. The cross-pollinative team learning (CTL) design studio pedagogy was operationalised in a year-long randomised controlled trial with first-year Generation-Z beginning design students to resolve the limitations in the existing pedagogy. The CTL students were significantly less anxious compared to master-apprentice students at the year end, although the impact of both pedagogies on anxiety was relatively modest. The hidden CTL curriculum and social support were also demonstrated to enable CTL students to outperform one-on-one master-apprentice learners academically. This study suggested that the power structures of design studios should be recalibrated to acquire CTL advantages, thereby leading to more effective learning outcomes.

Keywords:
Social support, heterarchical studio pedagogy, cross-pollination, power structures, hidden curriculum.

STUDY BACKGROUND AND FOREGROUND: DESIGN LITERACY AND PEDAGOGY

Creativity and design skills are essential to encouraging innovation in the knowledge economy to navigate the 21st century with the increasing challenges of volatility, uncertainty, complexity, and ambiguity (Howard, 2016) especially after the coronavirus disease (COVID-19) pandemic. Design educators and researchers emphasise the importance of design literacy as a foreground and relevant role in the future economy. Moreover, students are encouraged to acquire proficient design skills to engage and empower students without a design background (Christensen et al., 2019; Green, 2014; Nielsen & Brænne, 2013) to participate in a collaborative and heterarchical design process. Nevertheless, the conventional master-apprentice pedagogical model persisted with design educators' preoccupation with attaining design literacy (Davis, 2017; Jolliffe & Crosby, 2023; Liow, 2016; Sunwoo,

2012; Webster, 2004). Nielsen and Brænne's (2013) framework for design literacy education demonstrated that the master-apprentice approach was ineffective in advocating democratic ideals through participation and dialogue, which inhibited the exploration of ideas.

Learners' feelings of anxiety are increased by the associated hidden curriculum of the master-apprentice pedagogy (AIAS, 2008; Kirkpatrick, 2018; McClean, 2020; Stead et al., 2022), which limits learners' inherent potential to excel academically and subsequently leads to academic underperformance (Liow, 2021a; Liow, 2022). The hidden curriculum is a by-product of imparting knowledge that preserves non-cognitive traits, values, behaviours, and principles of professional practices (Davis, 2017; Dutton, 1987; Stead et al., 2022), which are surreptitiously re-enacted, enforced, and incorporated as a studio culture (Austerlitz et al., 2008; Dutton, 1987; Howlett Brown, 2022; Webster, 2005). Craig et al. (2018) and Meghani and Harvey (2016) delineated that students' enculturated behaviours and mindsets would be normalised and manifested accordingly in the upper years. Hence, the present study investigated the impacts of a recalibrated power-structured design studio pedagogy with actively engaged cross-pollinative design conversations through social support on reducing the negative impact of the widely practised one-on-one master-apprentice hidden curriculum.

The current study highlighted the need for design literacy to support future economies with heterarchical systems and design processes that would actively engage non-designers. A discussion was also established on the characteristics of the daily formative master-apprentice or one-on-one desk critiques for the authoritative master-apprentice relational pedagogy. Particularly, Nielsen and Brænne's (2013) framework for design literacy education assisted in defining the optimal conditions of design literacy in educational settings. An experimental cross-pollinative team learning (CTL) design studio pedagogy through social support (student-to-student and tutor-to-student relationships) was hypothesised to generate positive impacts on students, owing to social support being revealed to benefit emotional well-being (Awang et al., 2014; Friedlander et al., 2007; Kantanis, 2000; Rayle & Chung, 2007) and academic achievement (Meehan & Howells, 2018, 2019; Strolin-Goltzman et al., 2016). Hence, the importance of integrating collaboration and student-to-student social support into the CTL pedagogy was underscored for the current Generation Z learners when enrolling in higher education.

A year-long randomised controlled trial (RCT) was operationalised for beginning design students between 17 and 18 years old enrolling in an Asian higher educational institution to understand the effects of heterarchical pedagogical systems on students' anxiety and academic scores. The RCT parameters were expounded simultaneously with the research design limitations. Students' anxiety levels were measured twice via the self-reported Generalised Anxiety Disorder-7 (GAD-7) scale (Spitzer et al., 2006) at the end of both semesters. The GAD-7 and academic scores were analysed through the t-test to determine statistical significance within and between the groups. Specifically, CTL students significantly outperformed the master-apprentice peers academically throughout the year despite only experiencing slightly less anxiety, which necessitated further exploration of students' experiences. Summarily, this study reinforced the importance of re-evaluating the prevalent the master-apprentice model for more equitable modes of design pedagogy. The experimental CTL pedagogy sought to inculcate collaborative mindsets as the heterarchical teaching model catalysed the production of democratic ideals through participation and dialogue. Figure 1 outlines the current study structure and scope in a relational diagram.

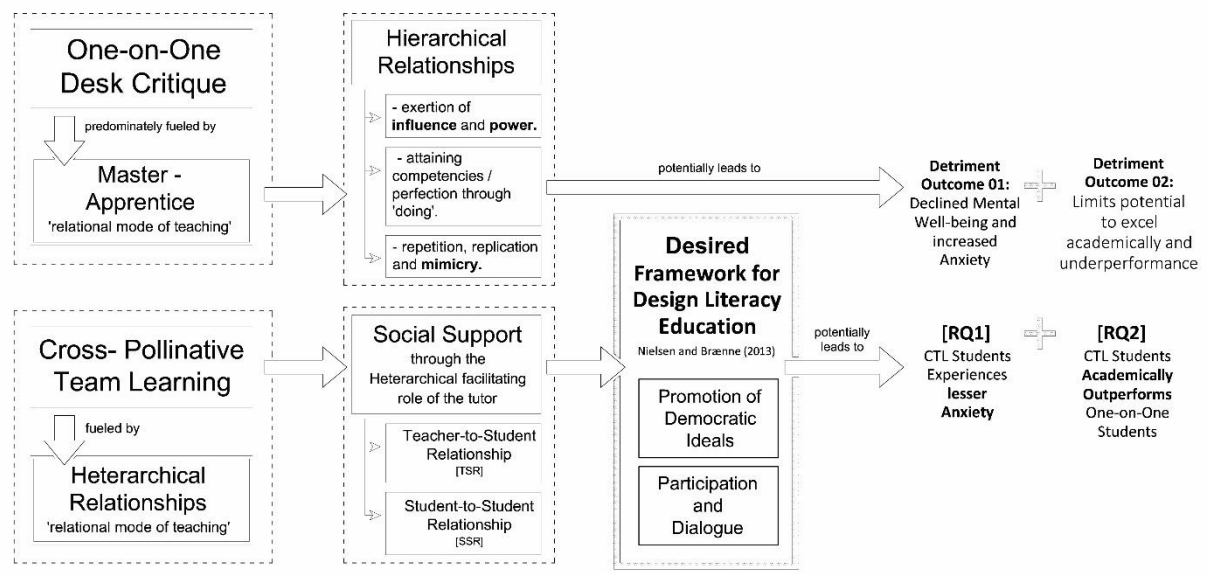

FIGURE 1. The Contextualised Framework of the Relational Mechanisms between the One-on-One and CTL Pedagogy.

DESIGN LITERACY: TOWARD HETERARCHICAL DESIGN PROCESSES AND PEDAGOGIES

Increased global economic uncertainties and seismic cultural changes resulted in multifaceted challenges and opportunities. The emerging empathy economy is perceived to be extensively influential (Dellot et al., 2019), which is underpinned by knowledge production and dissemination (Powell & Snellman, 2004) with technological outputs as major drivers. The empathy economy capitalises on developing holistic user or consumer experiences (McDonagh et al., 2018) through non-hierarchical design processes. Tan (2020) argued that diversified knowledge collection and decision-making assist in preventing major collapses by allowing for minor errors through decentralised and heterarchical power structures, which is increasingly strategic in the post-pandemic era. Hence, questioning the dominant paradigm of solely depending on expert designers to perform critical design decisions is imperative.

The expanded position of design is catalysed by adopting a collaborative process of diverse discourses investigating emergent epistemologies that engage non-designers as end-users in co-creating human-centred solutions tackling societal challenges (d'Ippolito, 2014; Design Singapore Council, 2020; Tan, 2020) while promoting economic competitiveness (Lutnæs, 2021). The potential of such heterarchical design systems potentially resolving imminent global challenges of the 21st century could be strengthened by foregrounding the importance and ethos of design literacy (Nielsen et al., 2014). Lutnæs (2021, p. 10) contextualised and defined design literacy through an extensive review as empowering individuals to be "aware of both positive and negative impacts of design on people and the planet, approaching real-world problems as complex, voicing change through design processes, and judging the viability of any design ideas in terms of how they support a transition toward more sustainable ways of living".

The complex interplay between academia and society or actual practice necessitates an examination of current design studio pedagogies to accomplish the aforementioned objectives (Fullan, 2021). A significant implication is to envisage a shift from the conventional hierarchical paradigm in professional practice and academia toward heterarchical creative methodologies. The transition underscores the vital role of design literacy in engaging non-designers for greater impact (Christensen et al., 2019; Green, 2014; Nielsen & Brænne, 2013) facilitated by designers. Nonetheless, the ubiquitous design studio pedagogy contextualised within the discipline of architecture, namely the Master-Apprentice approach, remains a deterrence when educators proceed with the largely unchallenged one-on-one master-apprentice studio pedagogy to equip students with fundamental skill sets in achieving the desired threshold level of design proficiency and collaborative mindsets.

THE MASTER-APPRENTICE MODEL AS THE DOMINANT DESIGN PEDAGOGY IN ARCHITECTURE EDUCATION

The architectural educational format and structure have remained similar since the late 1950s, although architectural education is frequently perceived as radical and progressive (Jolliffe & Crosby, 2023). The predominant design educational pedagogy (Crowther, 2013) is the authoritative master-apprentice pedagogical approach (Turkkan, 2016), which refers to experienced professionals or masters guiding and mentoring less experienced individuals or apprentices. The ubiquitous system comprises a group of students learning various design methods under the tutorship of a studio master and is employed by numerous architectural schools worldwide (Davis, 2017; Jolliffe & Crosby, 2023; Liow, 2016; Sunwoo, 2012; Webster, 2004). The master-apprentice model of knowledge transfer originates from medieval construction sites (Mewburn, 2009), the Ateliers of Beaux-Arts (Davis, 2017), and the Bauhaus workshops (Celani, 2012), frequently incorporate the formative one-on-one desk critiques with a tutor-student ratio of 1:9 to 1:12. Figure 2 depicts a diagrammatic analysis of the one-on-one design studio model.

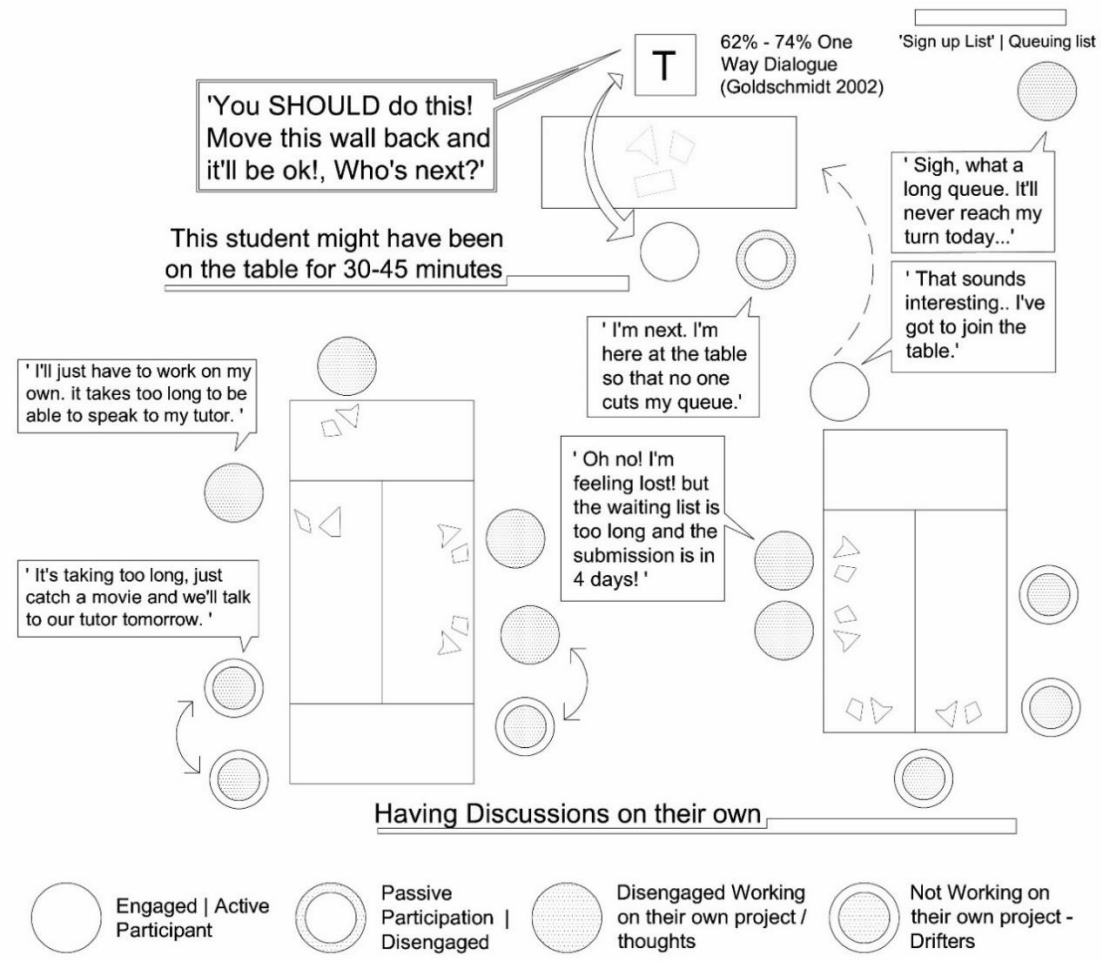

FIGURE 2. An illustration depicts the asymmetrical power dynamics and the mass disengagements of students in a typical one-on-one studio (Liow, 2019).

One-on-one desk critiques are customary practices preferred by students (Tafahomİ, 2022) in studio settings, wherein learners present ideas for a specific assignment and receive formative feedback from a studio master who responds, critiques, and guides the learners (Goldschmidt et al., 2010; Smith & Boyer, 2015). The asymmetrically power-structured master-apprentice pedagogical model remains ubiquitous as the core design disciplines (Achten, 2015; Ahmad et al., 2020; Brzezicki, 2020; Ceylan et

al., 2021; Charters & Murphy, 2021; Dannels & Martin, 2008; Demirbaş & Demirkan, 2003; Flynn et al., 2019; Flynn et al., 2022; Goldschmidt, 2002; Goldschmidt et al., 2010; Hacihasanoglu, 2019; Jones, 2023; Koh, 2020; Liow, 2016, 2019; Mewburn, 2012; Saghafi, 2020; Smith & Boyer, 2015; Webster, 2004, 2005), despite Jolliffe and Crosby (2023) querying about the relevance of the unchallenged system. Moreover, numerous educators advocated the master-apprentice model as a constructivist and student-centric approach (Kurt, 2009; Smith, 2022; Wilson & Jennings, 2000), which could increase the opportunities for critical thinking (Bose et al., 2006), personalised learning (Tafahomİ, 2022), collaboration (Yevenes et al., 2020), and reflective practices (Wang & Lv, 2017) in the studio. Mewburn (2012) describes desk critiques as a collaborative pedagogy, which serves as a form of role-playing among students to assume the role of the 'novice architect' and the teacher as multiple authoritative roles, including the experienced architect, client, or consultant, instead of facilitating as teammates or capable peers.

Master-apprentice model and the hidden curriculum: asymmetrical power structures

The modus operandi of the master-apprentice model is for students to learn by actively participating (Flynn et al., 2019; Flynn et al., 2022) and imitating the techniques in the studio, which adheres to the artisan traditions of imparting craft techniques (Davis, 2017). The primary aim is to attain mastery through replication, practice, repetition, and emulation predicated on the certainty of predetermined outcomes. The master imparts hard skills and inculcates non-cognitive attributes, values, behaviours, and principles of professional practices through the hidden curriculum (Davis, 2017; Dutton, 1987; Stead et al., 2022). The ambiguous nature of design studios (Al Maani & Roberts, 2023; Orr & Shreeve, 2017; Temple, 2019) facilitates the inadvertent conveyance of tutors' aesthetics, intuitive design approaches, spatial cognition, and problem-solving strategies (Venkatesh & Ma, 2019), which is similar to the banking pedagogy that learners are regarded as empty vessels to be filled up with knowledge rather than being co-creators (Freire, 1970).

The master-apprentice asymmetrical power structures persist in maintaining dominance while refusing to demystify the 'mystery-as-mastery' (Argyris & Schön, 1974; Banham, 1990) pedagogy and tacitly positioning the masters as the sole creative genius (Jolliffe & Crosby, 2023) to exert the power and creative expressions on learners. The power disparities and a lack of possibilities for reciprocal learning and interaction in the master-apprentice pedagogical relationship contribute to an oppressive learning environment (Howlett Brown, 2022). Furthermore, the hidden curriculum enacted in the design studio negatively impacted the pedagogical culture (Masatlioğlu & Parker, 2017) when enculturated behaviours and mindsets were normalised and manifested accordingly (Craig et al., 2018; Meghani & Harvey, 2016). The following section expands Nielsen and Brænne's (2013) proposition that design literacy advocates general design education for citizenship by promoting democratic ideals through participation and dialogue within an educational context to critique the impotence of the pervasive master-apprentice model as the dominant design approach in architecture education.

Democratic ideals: the master-apprentice model toward divergent design explorations and collaborative pedagogies

Multiple studies indicated that formative design reviews generally advocated replication and mimicry (Al Maani & Roberts, 2023; Bandini et al., 2017) and fostered conformity (Braaten, 1964; Crowther, 2013; Dutton, 1987; Flynn et al., 2019; Flynn et al., 2022; Ward, 1990; Webster, 2005) instead of promoting creativity. Flynn et al. (2022) explicated that design critiques within the instructivist paradigm align with the master-apprentice model rather than the widely shared idealised perspective of the design studio as a student-centred (social) constructivist model. The master-apprentice model is solely a simplistic punishment-or-reward principle (Salama & Burton, 2022) that discourages radical explorations and innovation due to the potentially high rejection from the masters (Achten, 2015). Another characteristic of the master-apprentice model may provide prompt answers at first instances without an extended discussion to alleviate students' confusion (Green & Bonollo, 2003). The master-apprentice pedagogy could potentially impose particular ideas and behaviours (Brown et al., 1989; Lave & Wenger, 2000; Wang, 2019) on students as the master tutor possesses significant control and influence over the

learning process, ideas, and perspectives (Bohemia & Harman, 2006). Therefore, design tutors influence design facilitations with biased assumptions and stylistic preferences through the dogmatic process of replication and mimicry (Al Maani & Roberts, 2023; Bandini et al., 2017). Additionally, strict adherence to the master could stifle creativity and independence. Nevertheless, certain students might be more willing to unilaterally receive tutors' ideas as absolute instructions (Dutton, 1991) rather than a design process, in which divergent trajectories are discussed (Liow, 2021b; Webster, 2005).

Learners' tasks in team or group projects are frequently limited to descriptive exercises, such as case studies or site analysis, as introductory factual investigations (Jolliffe & Crosby, 2023; Liow, 2019), as such group projects scarcely occur in design education (Jolliffe & Crosby, 2023). Tutors continue to uphold the traditions of one-sided pedagogy by considering that education mirrors society (Fullan, 2021), which further preserves the asymmetrical power balance. The design feedback provided by the sole tutor frequently results in students' unilateral receipt to a singular worldview without examining competing perspectives. As Wrigley and Mosely (2022) argued that students must be exposed to multiple approaches to addressing the same issue in the early stage of design education, the top-down provision of design suggestions remains a barrier to inculcating the required mental agility in design education. Students present in a discussion do not propound the effectiveness or presence of democratic approaches (Liow, 2016). Instead, the important process of negotiating conflicting ideas needs to be catalysed through a discursive and safe environment.

Participation and dialogue

Smith (2022) emphasised that knowledge acquisition is the most effective when being co-constructed with collaborative conversations between tutors, peers, and peer-to-peer interactions through negotiation processes. The efficacy of design reviews conducted exclusively between the master and apprentice raises questions regarding the authenticity of the dialogue. Baum (1977) delineated that authentic dialogue occurs only between equals, in which the master would only listen when the authority is maintained and the apprentice would only speak when no punishment would be imposed. The unilateral design conversation model in the one-on-one desk critiques (Goldschmidt, 2002) deters the establishment of trusting relationships (Barton, 2022), which undermines the efficacy of establishing positive learning experiences (Yorgancıoğlu & Tunalı, 2020). Resultantly, numerous opportunities were neglected for learners to discover alternative knowledge when students potentially learn methods to discuss, argue, and negotiate through academic discussions. The one-sided pedagogy was ineffective in transforming passive listeners into engaged contributors, thereby resulting in a studio environment that demonstrated growing tendencies toward individualism and competitiveness (Liow, 2016). Furthermore, Liow (2016) reported that non-engaged students who encountered challenges in self-motivating to maintain pace with the studio educational progress would be more inclined to quit the programme.

The indifferent attitude of educators toward collaborative pedagogies (Jolliffe & Crosby, 2023) posits that engaging students' participation in the joint discussion of individual projects is ineffective, which highlights the importance of initial fact-gathering group projects have adequately addressed the concern of communication and collaboration skills. Students typically separate and complete different parts of an assignment before combining the completed parts incoherently into a single submission, which squanders opportunities to glean benefits from participating in an engaging discourse. Exploratory discussions could uncover diverse design ideas while enriching students' minds as the dialogical nature serves as a primary driver. Comparatively, the prevalent master-apprentice pedagogy inhibits learners' active interactions, limits discourse on alternative possibilities, and diminishes confidence in defending personal ideas. Limited participation and cross-pollinative dialogues in design studios also pose a massive challenge for students when embarking on professional careers (Jolliffe & Crosby, 2023). Students are more predisposed to be indoctrinated into a single ideology and develop into non-critical thinkers when continuing as passive learners throughout the academic journey.

DETRIMENTS OF THE MASTER-APPRENTICE PEDAGOGY

Recent studies revealed that one-on-one master-apprentice pedagogy contributed to students' deterioration of psychological well-being (Howlett Brown, 2022; Olweny et al., 2021; Stead et al., 2022) and substandard academic outcomes (Liow, 2021a; Liow, 2022), which remains prevalent to date (Brown, 2021; Crowther & Briant, 2022; Stead et al., 2022). Empirical studies investigating alternative pedagogical frameworks as interventions to alleviate the stress and anxiety resulting from the hidden curriculum remained scarce (Stead et al., 2022), although an abundance of argumentative literature discussing the determinants of the hidden curriculum in master-apprentice studios on learners' mental well-being was available.

Anxieties and mental well-being in the master-apprentice studios

Anxiety symptoms are characterised by excessive expectations of future threats, fears, and worries that create significant distress and interfere with an individual's daily functioning (American Psychiatric Association, 2013), which poses immediate threats to mental well-being. Mental well-being extends beyond the absence of mental health conditions to enable individuals to realise personal potential, be resilient amidst adversities, function productively, form meaningful relationships, and contribute to respective communities (World Health Organisation, n.d.). The demanding nature of design courses and the intensely individualistic competitive learning environment created significant stress for design students (AIAS, 2008; Gümüşburun Ayalp & Çivici, 2021; Hegenauer, 2018; Howlett Brown, 2022; Jia et al., 2009; Karklins & Mendoza, 2016; Kirkpatrick, 2018; Leon et al., 2014; McClean, 2020; Olweny et al., 2021; RIBA, 2017, 2018; SONA, 2022; Stead et al., 2022; Xie et al., 2019) and negatively impacted student mental well-being since the 1960s (Braaten, 1964) as the main detriment (Kirkpatrick, 2018). Furthermore, design criticisms that emerge toward beginning design students might be unconsciously internalised as intimidating acts, which produce negative emotions of failure and incompetence. The percentage of students experiencing mental health problems also increased due to difficulties following the tutor's instructions and coping with the high expectations of the tutor (Liow, 2021a).

The fiasco at the Bartlett School of Architecture exposed decades of abuse, misogyny, immense stress, and concerns primarily attributed to a lack of accountability in the master-apprentice asymmetrical power structures in the Unit-systems (Howlett Brown, 2022). The Howlett-Brown report underscored that the siloed Unit-systems bestowed tutors with huge authority and influence, which allowed tutors' biases to impact the grading of students' work. The revelation of the oppressive learning environment exemplifies the existing notion of "public successes but private failures". Al-Irhayim (2022), who was the Royal Institute of British Architects (RIBA) vice-president of students, expounded a similar view after visiting various architectural schools and exhibited low faith in the British architecture institutions. To-date, limited studies investigated alternative design pedagogies to alleviate student stress despite the high emphasis on students' mental well-being.

SOCIAL SUPPORT AS A MODERATOR TO DECREASE ANXIETIES WHILE IMPROVING ACADEMIC OUTCOMES

Social support enables individuals not to feel alone amidst adversities (King & Rothstein, 2010) as social relationships involve sharing, affirming, or endorsing an individual's beliefs and endeavours (Kahn & Antonucci, 1980). Social support is defined as the assistance received by individuals through interactions with other individuals (Lakey & Cohen, 2000; Peplau, 1985) rather than the sole presence of social interactions (Hupcey, 1998). Folkman and Lazarus (1991) also explained that social support occurs simultaneously as problem-focused scenarios (receiving information and assistance that supports the individual in resolving issues) and emotional-focused coping strategies (assistance and support that assists in regulating emotions arising from adverse and stressful episodes. Prior scholars emphasised the importance of social support in reducing the adverse psychosocial effects of depression, anxiety, low self-efficacy, and stress (Denis et al., 2015; Hurd & Zimmerman, 2010; Kort-Butler, 2017; Lakey & Cohen, 2000; Mohammad et al., 2015; Ozbay et al., 2007; Stewart et al., 2014; Wilson et al., 2017) to promote mental well-being as buffering mechanisms against the harmful effects of stress (Cohen et al., 2000; Lin & Peek, 1999). Henderson (1992) evaluated 35 studies and discovered significant negative

associations between social support and mental well-being. The effects of social support in counteracting life stress are pivotal (Turner & Brown, 2010) as such processes are embedded in an individual's daily activities. Social support interventions are the most effective when directed at naturally occurring social networks (Brand et al., 1995) and aided by interactions and insights acquired from discussing the issues with other individuals (Spreitzer et al., 2005).

Academic social support: student-to-student relationships (SSRs) and mental well-being implications

Previous researchers highlighted the importance of social relationships, social support, and friendships in assisting first-year students in adapting to higher education (Awang et al., 2014; Friedlander et al., 2007; Kantanis, 2000; Rayle & Chung, 2007). Academic achievement (Lisa et al., 2010; Masten & Coatsworth, 1998; Meehan & Howells, 2018, 2019; Strolin-Goltzman et al., 2016; Wyman et al., 1999; Yazedjian et al., 2007) and mental well-being (Awang et al., 2014; Friedlander et al., 2007; Kantanis, 2000; Rayle & Chung, 2007) were positively associated with first-year students who developed social networks. Peer relationships in academia were also advocated as a promotive factor to leverage positive adaptations in inculcating academic resilience. Therefore, the student-to-student relationship (SSR) aspect of social support provides camaraderie when students experience similar issues with mutual peers (Kantanis, 2000), which creates a safe environment to express personal concerns and frustrations.

Academic social support: tutor-to-student relationships (TSRs) and academic implications

The efficacy of social support depends on the centralities of the tutors (Rosenfeld et al., 2000) manifested as tutor-to-student relationships (TSRs) as adolescent students spend a massive amount of time in educational settings. Hagenauer and Volet (2014) highlighted that TSRs consist of both affective and supportive dimensions that contribute to the social support mechanism. The affective dimension addresses the caring aspects involved in student learning that inculcate self-directive intrinsic motivation (Komarraju et al., 2010). The supportive dimension refers to the approachability (Denzine & Pulos, 2000) and promptness to address learners' questions by articulating the expectations of the assignment. Being supportive does not necessarily suggest excessive coddling of learners. Instead, educators could stipulate high academic aims and collaboratively attain the objectives with adequate scaffolding (Devlin & O'Shea, 2012).

Sibii (2010) defined the tutor's role in TSRs as a friendly individual rather than a friend. The TSR field remains under-explored in the context of higher education despite the significance (Hagenauer & Volet, 2014). The same sentiment also reverberates from the lack of investigation into the nature of the interaction between students and tutors in design studios (Karabulut & Celikoglu, 2019; Ochsner, 2000). Hence, this study underscored tutors' crucial role in strengthening social support to improve beginning design students' academic performance and mental well-being. According to Meehan and Howells (2018) and Meehan and Howells (2019), students' transitions to higher education were highly dependent on social interactions facilitated by academic staff with whom the learners collaborated closely, which could result in a sense of belonging. The validity of the claims was also supported by past researchers (Masten & Coatsworth, 1998; Strolin-Goltzman et al., 2016; Wyman et al., 1999), who revealed encouraging associations between academic performance and positive TSRs.

Social support in intertwined generation Z groups: academic and mental well-being implications

Appraising Generation Z students' characteristics is vital to comprehending the specific intricacies of SSR social support. Generation Z learners are considered digital natives born between 1996 and 2012 (Singh, 2014), who grew up in a borderless digital world supported by social media. The social support networks of Generation Z SSRs are frequently structured by the propensity to collaborate in intertwined groups (Sladek & Grabinger, 2014). The constant flow of co-constructed information in social media networks and online forums reinforces the need to incorporate diverse viewpoints in establishing personal worldviews. Co-constructing knowledge through collaboration (Katz et al., 2022; Schwieger & Ladwig, 2018; Sladek & Grabinger, 2014) accompanied by peer-to-peer communication is also a crucial element of Generation Z students' preferred learning and communication approaches. Gathering peer-to-peer information from active participation in specifically established virtual communities (Katz et al.,

2022), could bridge knowledge gaps in academic and recreational endeavours, with social networking or communication demonstrating the two main focuses of social support, namely problem and emotional-focused assistance. In addition, the tendency of Generation Z students to interact in groups suggested that the social support extended the interaction beyond two close individuals to larger groups or teams. As such, educators could replicate the virtual socialised environment in physical studios. The critical peer-to-peer (P2P) mechanisms for the heterarchical CTL pedagogy could be established by embracing the proclivity of Generation Z students to interact in social support networks as forms of knowledge gathering and validation.

A CTL STUDIO PEDAGOGY GROUNDED IN SOCIAL SUPPORT

The underlying CTL concept is anchoring heterarchical TSRs during formative reviews and extending SSR camaraderie to induce social support for academic cross-pollination for improved academic performance and mental well-being. Cross-pollinative studios have been present in academic and professional settings, wherein designers from different disciplines collaborate on a single project. Beginning design learners with diverse high school curricula, backgrounds, life experiences, and spatial perceptions could actively participate in CTL studios through constructive peer feedback. The CTL pedagogy, which is undermined by the stability of the TSR hidden curriculum, actively solicits and scaffolds cross-pollinative critiques among peers. Figure 3 illustrates the facilitating role of CTL design tutors, who actively engage students in the learning process.

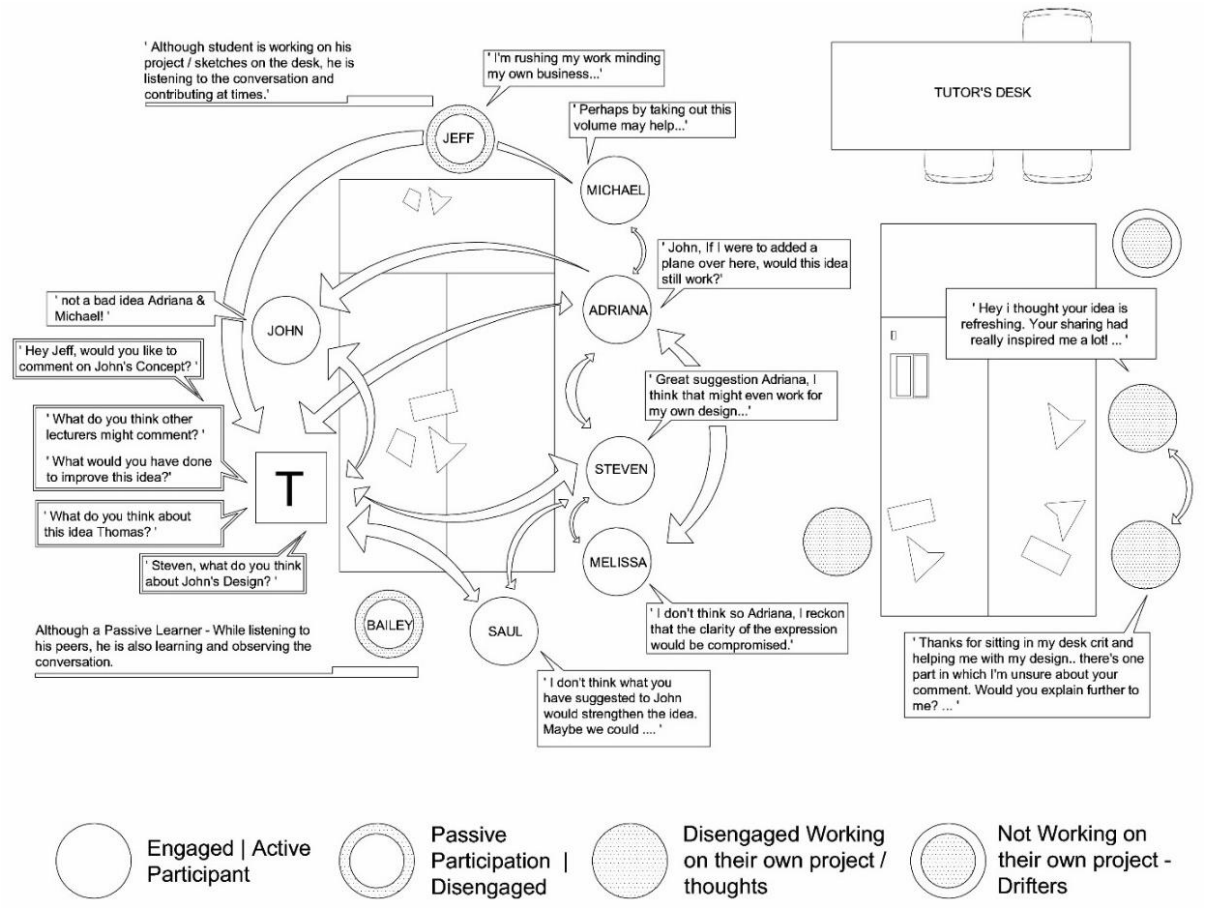

FIGURE 3. A typical CTL studio highlights tutors' active engagement and solicitation of design discussions (Liow, 2019).

The shared awareness of peers' design intentions and strategies encourages collective brainstorming and decision-making as integral components beyond the active facilitation of cross-critiquing. The CTL tutors lead a fast-paced exploratory exercise whereby students develop solutions for peers that could engage students to enhance their confidence in design sensitivities or capabilities whenever the design reviews become stagnant. Follow-up facilitations are subsequently augmented with alternative solutions provided by peers, which demystify the claim that tutors' feedback is absolute. Participating learners could assimilate different evaluation modes into SSR-structured lessons when the tutor demonstrates various approaches of critiquing, potentially aiding students' self-directed P2P cross-pollinative design discussions outside studio hours. Figure 4 portrays an example of a fast-paced CTL exercise. The CTL pedagogy can be effectively implemented not only in team or group projects but also in individual student design projects. One key component is that the nature and typology of the design project must be common among the students, in which managing students' expectations of heterarchical engagements is essential. The CTL tutors could explain the rationale of the heterarchical pedagogy and encourage students to commence the semester with an open mind. Moreover, CTL sought to enhance academic outcomes and mental well-being by leveraging relationship-building to foster a positive studio culture. The continuity of cross-pollinative approaches could lead to the normalisation and spontaneous practice of diverse behaviours and mindsets (Craig et al., 2018; Meghani & Harvey, 2016) into their senior years.

FIGURE 4. The CTL pedagogical processes result in a combination of tutor prompts and brainstorming with participating students.

RESEARCH DESIGN

Limited empirical studies assessed the buffering effects of social support on mental well-being challenges in a design studio setting despite the optimal pedagogical and social conditions. A randomised controlled trial (RCT) was conducted to determine the possible effects of the heterarchical CTL pedagogy. The RCTs are prospective, comparative, and quantitative studies conducted under controlled

conditions, with random allocation of participants to experimental and control groups (Bhide et al., 2018). The RCTs were initiated in medical fields before being extensively recognised and advocated as a quality research method, thereby establishing the basis for translating research results into actual practices (Spieth et al., 2016). Participants in both groups were followed-up to determine the differences in the results to assess the effectiveness of the intervention (Bhide et al., 2018; Kendall, 2003). The year-long RCT measured the impacts of the two pedagogical approaches in a beginning design studio by comparing potential effects within and between groups on students' anxiety levels and academic scores. Threats of selection bias and the negative impacts of confounding variables were minimised by randomly assigning the students to 10 individual studios with 20 students each performed by the programme administrators (Bhide et al., 2018). Learners from two studios were invited to participate in the study recognised as 'Learning Experiences in the Studio', with 15 students from the CTL studio and 14 students from the one-on-one master-apprentice group. The students were assured that the involvement would remain private and not influence respective academic grades. Learners' enrolment into this design foundation course depended on personal performance in STEM-focused national GCE 'O' level examinations and similar age groups (17 to 18 years) for comparable academic abilities.

Parameters: curriculum, assessment, and blinding

The Asia-based institution adopted an integrative approach in which design, construction, and environmental courses were integrated into design projects, with studio peers remaining consistent throughout the academic year. Both CTL and one-on-one studios were scheduled on the same days each week, with weekly eight-hour studio sessions and similar student-to-teacher ratios across the cohort. Project scores were jointly accessed by a panel of three or more lecturers via an identical marking rubric and markers were blinded to the existence and allocation of learners from respective groups. As such, bias and expectations in evaluating CTL students' academic performance were reduced. The design tutor facilitating the master-apprentice studio (control group) was also blinded to the allocation and the nature and existence of the treatment group to prevent additional attention to CTL students (Schulz et al., 1995). Learners in both pedagogy groups were concealed from respective assigned groups as beginning design students completing GCE examinations would possess limited preconceptions of how design discussions were facilitated. Furthermore, the teaching strategies in both studios were visually indistinguishable as learners from both groups tended to crowd round the teacher's table.

Measuring anxieties: generalised anxiety disorder-7 scale (GAD-7)

Students' anxiety levels were measured via a paper-and-pen survey at the end of each semester as data points (DP) 1 and 2. The self-reported Generalised Anxiety Disorder-7 (GAD-7) scale (Spitzer et al., 2006) was administered twice at the end of each semester after project submission and before the release of student grades to prevent influences on accurate reflections from academic results. The Cronbach's alpha value of the GAD-7 scale was 0.92, which indicated high internal consistency and sufficient test-retest reliability determined by criterion, construct, factorial, and procedural validity. The primary contextual question was: '*Over the last two weeks, how often have you been bothered by the following problems?*' in the 7-item scale. Participants answered from 1 as strongly agree to 7 as strongly disagree for sample questions, such as '*Not being able to stop or control worrying*' and '*Feeling afraid as if something awful might happen*'.

RESEARCH QUESTIONS AND HYPOTHESES

This study examined the potential effects of both pedagogy groups on students' anxiety levels and academic scores, which assisted in formulating the following research questions:

> *RQ1*: Does a significant relationship exist between studio pedagogical methods and resultant *anxiety levels*?

Two hypotheses were also developed for RQ1, namely RQ1a and RQ1b. RQ1a compares means within the group as CTL students were hypothesised to experience lower anxiety degrees in the academic year. RQ1b compares means between the groups as CTL students were hypothesised to experience lower anxiety levels when compared to master-apprentice peers. The two corresponding null hypotheses were the CTL pedagogy did not significantly reduce students' anxiety levels:

> RQ1a - H0: μ2 (CTL anxieties at DP2) - μ1 (CTL anxieties at DP1) = 0 and the corresponding alternative Hypothesis - H1: μ2 (CTL anxieties at DP2) - μ1 (CTL anxieties at DP1) > 0.
>
> RQ1b - H0: μ2 (CTL anxieties at DP1 and DP2) - μ1 (One-on-One anxieties at DP1 and DP2) = 0 and, the corresponding alternative Hypothesis - H1: μ2 (CTL anxieties at DP1 and DP2) - μ1 (One-on-One anxieties at DP1 and DP2) > 0.
>
> *RQ2*: Does a significant relationship exist between studio pedagogical methods and students' *academic scores (acad)*?

Two hypotheses were developed for RQ2, namely RQ2a and RQ2b. RQ2a compares means within the group as CTL students were hypothesised to achieve higher academic scores. RQ2b compares means between the groups as CTL students were hypothesised to outperform academically when compared to master-apprentice peers. The two corresponding null hypotheses were the CTL pedagogy did not significantly impact students' academic scores:

> RQ2a - H0: μ2 (CTL acad Scores at DP2) - μ1 (CTL acad Scores at DP1) = 0 and the corresponding alternative Hypothesis - H1: μ2 (CTL acad Scores at DP2) - μ1 (CTL acad Scores at DP1) > 0.
>
> RQ2b - H0: μ2 (CTL acad Scores at DP1 and DP2) - μ1 (One-on-One acad Scores at DP1 and DP2) = 0 and, the corresponding alternative Hypothesis - H1: μ2 (CTL acad Scores at DP1 and DP2) - μ1 (One-on-One acad Scores at DP1 and DP2) > 0.

Data analysis

The t-test, which is highly regarded as the main RCT analytical method (Allen, 2017), is a conventional approach to reduce the occurrence of type I errors, which incorrectly rejects the null hypothesis (Gandhi et al., 2011). The necessary statistical assumptions for the t-test were delineated and reported in the Results and Discussion section. A resultant probability level (p-value) of below 0.05 would validate observed significant differences in corresponding means.

Confounding factors: baseline readings

The RCTs are generally considered the standards of rigorous and robust research methodologies (Bhide et al., 2018). Nonetheless, potential errors in the research design, such as bias, confounding variables, and chance, could manifest as threats to the validity of findings (Kendall, 2003). Confounding variables are inherent aspects of the participants associated with the study outcome and intervention that could reduce the accuracy of the results. The limited experience of beginning design students with studio pedagogies and the concealed randomisation to respective groups significantly reduced the negative impacts of confounding factors. The need to measure the baseline values before commencing data collection is frequently contested. Scholars argued that assessing baseline conditions before the study commencement should be conducted when analysing outcomes (Begg et al., 1996; Kendall, 2003). Nevertheless, only 99 studies adjusted outcome values from the initial baseline readings in a review of 187 out of 200 RCT clinical studies that considered the baseline (Ren et al., 2022). Meanwhile, Bhide et al. (2018) and Torgerson and Torgerson (2013) propounded that tendencies to consider the baseline of the variables reflected apprehensions about the integrity of the randomisation process as any effect caused by baseline readings must be regarded as chance.

A clearer picture of the baseline or pre-test value was provided by assessing students' anxiety levels after the initial exposure to the design studio culture consisting of an introductory design primer project with reduced complexity and subjectivity. A possible increase in anxiety could be attributed to learners' apprehension of a different learning environment, such as acquainting with different individuals or the stress of fulfilling expectations conveyed by parents or self-defined, if the GAD-7 pre-test was administered during the matriculation week. The first administration period for the GAD-7 scale was at the end of the first semester, wherein sufficient experience with ambiguous design pedagogy could yield a more precise finding of students' initial anxiety levels. Therefore, the current RCT could assist in understanding the effects of the intervention via two post-tests in educational research (Torgerson & Torgerson, 2013).

Research methodology limitations

Experimental research could provide causal findings within specific parameters, although the presence of unmeasured variables as constraints could limit the inference scope. Specifically, the experimental design lacked control over several factors that could potentially influence the results, such as the tutors' pedagogical predisposition. High-achieving students who were randomly assigned to the master-apprentice group might possess additional obligations outside academia, which limited the study time compared to CLT students. Moreover, the current study could not establish and verify the consistent implementation of the master-apprentice structured pedagogy throughout the study duration. The relatively small sample size in this study might not be generalisable to the general population, despite the results suggesting effective approaches for future pedagogical practices in similar contexts and prospective research trajectories. Generalisability or external validity is generally considered the constant limitation of educational RCTs (Connolly et al., 2017), although internal validities are robust. According to Cartwright and Hardie (2012) and Kvernbekk (2019), declaring that RCT study recommendations are completely generalisable is misleading due to the specificities of the unique context, sampled demographic profiles, and specific cultural conditions in each study. Kendall (2003) also emphasised that continuous outcome variables would provide more advantages over dichotomous outcome variables, which could assist in increasing the sample power for a study with a smaller sample size of below 50.

RESULTS AND DISCUSSION

Figure 5 illustrates the statistical test results, wherein both pedagogical frameworks produced minimal effects on student anxiety, except for DP2 which reported master-apprentice students to be significantly more anxious. The CTL students academically outperformed master-apprentice peers on both occasions despite the relative comparativeness of anxieties. This study also suggested that heterarchical CTL studio pedagogy could potentially moderate students' anxiety with the CTL-TSR academic conversational models for social support to enhance academic performance.

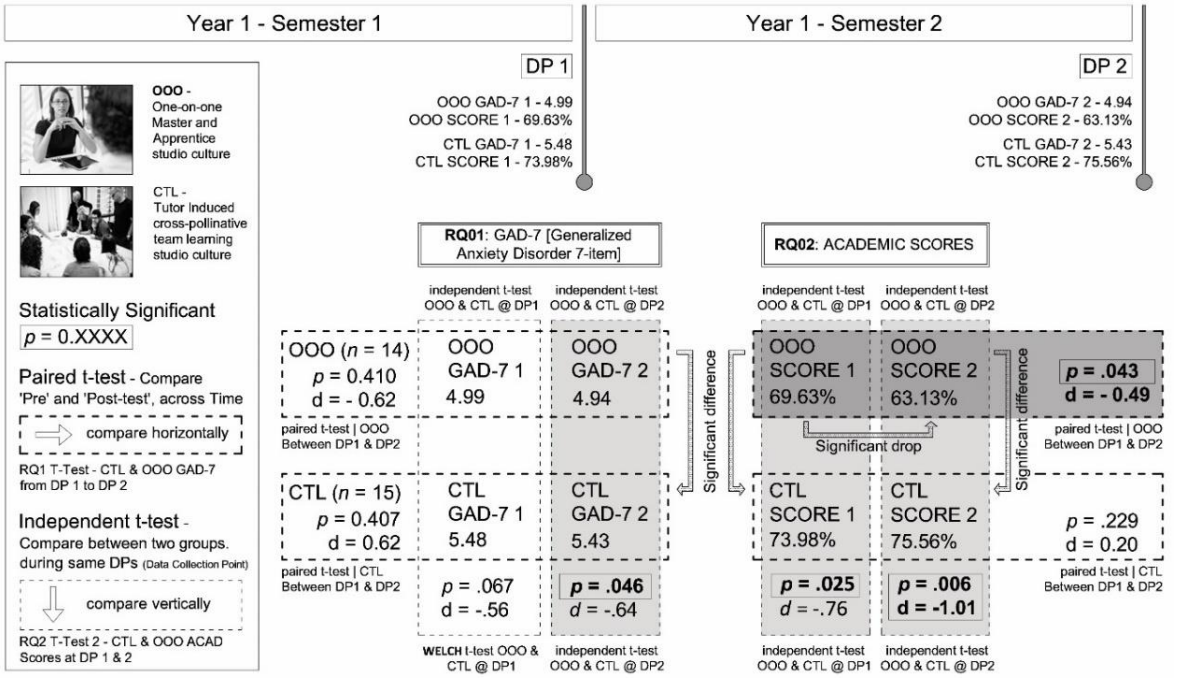

FIGURE 5. Combined Results of the Effects of the Variables within (Horizontal Comparison) and between Groups (Vertical Comparison) across two Data Points.

RQ1 results: pedagogy and anxiety

The Welch and independent t-tests were conducted to evaluate statistically significant variations in GAD-7 (anxiety) results between the two pedagogical groups. Paired t-tests were also conducted to assess the impact of pedagogical types on anxiety levels from DP1 and DP2. The Welch t-test was simultaneously employed as the assumption test to compare anxiety levels between both groups as DP1 was violated. The Welch T-test reflected that the 15 CTL students' anxiety readings at DP1 (M = 5.48, SD = 1.07) was higher than that of one-on-one learners (M = 4.99, SD = 0.53), which demonstrated no statistically significant difference (M = 0.49, 95% CI [-1.14 to 0.16], $t(20.855) = -1.56$, $p = .067$, $d = -.56$) with a medium effect size. The Independent T-test reflected that CTL students were less anxious at DP2 (M = 5.43, SD = 0.82) than one-on-one students (M = 4.94, SD = 0.68) with a statistically significant difference (M = 0.49, 95% CI [-1.06 to 0.86], $t(27) = -1.74$, $p = .046$, $d = -.64$) and a medium effect size.
The paired t-test revealed that the GAD-7 reading of the master-apprentice students decreased from DP1 (M = 4.99, SD = 0.536) to DP2 (M = 4.94, SD = 0.682) without a statistically significant difference (M = -0.05 (SD = 0.86), $t(13) = - 0.233$, $p = .410$, $d = - 0.62$) at a medium effect size. Similarly, CTL students' GAD-7 results declined from DP1 (M = 5.418, SD = 1.07) to DP2 (M = 5.43, SD = 0.78) without a statistically significant difference (M = 0.05 (SD = 0.80), $t(14) = 0.241$, $p = .407$, $d = - 0.62$) at a medium effect size. The alternative hypothesis of RQ1a was not supported for both pedagogical approaches as both groups similarly experienced an insignificant increase in anxiety. Contrarily, master-apprentice students were reported to be significantly more anxious than CTL students in DP2 despite the GAD-7 findings of CTL and one-on-one groups were comparable in DP1. Hence, RQ1b was accepted.

RQ1 discussion: pedagogy and anxiety with social support

The SSR social support has purportedly moderated students' anxiety levels in both pedagogical methods. The following sections discuss the potential and impact of social support on anxiety levels by a) elaborating on the TSR potential to support student well-being and b) exploring the impacts of the certainties from the master-apprentice studio, which could establish a false sense of confidence when encountering increased project difficulties in the second semester. The present study also expanded previous research findings (Denis et al., 2015; Hurd & Zimmerman, 2010; Kort-Butler, 2017; Lakey &

Cohen, 2000; Mohammad et al., 2015; Ozbay et al., 2007; Stewart et al., 2014; Wilson et al., 2017), which reported an inverse relationship between anxiety and social support.

a) The CTL-TSR potential in supporting students' well-being

Students' anxiety levels in the two groups were comparable, which postulated that the students benefited from and thrived on the camaraderie established from the SSR relationship. The insignificant increase in anxiety for both groups was initially perplexing, owing to Turner and Brown (2010) delineating that the efficacy of social support increased when individuals encountered stressful situations. Nevertheless, increases in anxiety were partially anticipated, particularly for the one-on-one group, as students were expected to demonstrate higher autonomy and academic competencies when experiencing design challenges with higher complexity in the following semester. Academic challenges and expectations were significant sources of stress and anxiety. The relatively stable anxiety levels of master-apprentice students might not be adequately moderated by the SSR social support in the socialised studio environment, which corresponded with the significant decline in academic performance. The observation posited that the stability of SSRs might not adequately provide sufficient academic benefits.

The affective dimension of the TSR academic conversational model operationalised in the CTL studios could explain master-apprentice students' significantly higher anxiety levels than CTL peers in DP2. A high-quality TSR academic conversational model empowers learners to be more explorative and engaged in learning activities while ensuring emotional safety for failures in respective explorations (Engels et al., 2021; Pianta, 1999). A safe and affective TSR plays an essential role in regulating students' negative emotions and anxiety (Drugli et al., 2011; O'Connor et al., 2011) when concealed challenges exist in the hidden curriculum of design studios (Dutton, 1987; Howlett Brown, 2022). Beginning design students might be inclined to actively contribute to the progress of peers' design schemes owing to the heterarchical learning environment being fostered and reinforced by CTL tutors' active prompts. The CTL open dialogue could encourage collaboration and boost students' confidence in developing design sensibilities and normalising failures. The positive traits could only be garnered when tutors actively engage students to participate in brainstorming and critiquing sessions, which effectively recalibrate the absolute power of tutors in master-apprentice studios toward a more inclusive learning environment.

The positive TSR academic conversational model manifested as cross-pollinative discussions and facilitated by the CTL tutor was perceived to elevate students' camaraderie. The TSR heterarchical hidden curriculum manifested in the cross-pollinative studio culture potentially alleviated the increased anxiety levels experienced in the second semester. However, limited empirical investigations were conducted to explore the strength of the relationships despite positive associations between TSRs and mental well-being (Zee & Roorda, 2018). Nonetheless, recent studies on elementary students indicated that TSRs contributed to lower anxiety and stress levels (Kurdi & Archambault, 2018; Li, 2022; Zee & Roorda, 2018). The CTL students' anxiety levels were significantly lower than those of the master-apprentice students in DP2, which supported the advocacy that a cross-pollinative culture should be efficiently implemented in the studios from the beginning stage. The implementation would ensure that a collaborative spirit could be instilled through the hidden curriculum, which reduces the competitiveness in students' academic journey through design courses when compared to their competing STEM (science, technology, engineering and mathematics)-based education. The observations also raised the question regarding the optimal time frame for a robust CTL hidden curriculum to decrease academic anxiety. Additionally, a gap existed in the sustainability regarding the effects of the CTL students' strengthened TSR social support after transitioning to the conventional one-on-one pedagogy in the upper academic years. Future longitudinal studies could address the two aforementioned gaps.

b) Impacts of master-apprentice students' anxieties due to pedagogical certainties and increased project difficulties

The certainties dispensed by the master-apprentice tutors in the first semester might prevent students from being exposed to the negative emotions of failure, which might result in false confidence and cause master-apprentice students to be significantly more anxious in the second semester. The increased

academic requirements, project complexities, and autonomy required of learners might serve as significant stressors. The SSR coping mechanism might become ineffective when one-on-one students could be demotivated amidst numerous difficulties, thereby exacerbating anxiety levels. Beginning design students might feel secure with adhering to the dogmatic pedagogical principles when the pedagogical certainties as formative feedback in the master-apprentice model were provided continuously. The engagement style in the master-apprentice model resembles the STEM pedagogies of high schools based on imitation, replication, and adherence. Comparatively, learners expect TSR tutors to convey higher expectations for collaboration to achieve success with adequate support (Devlin & O'Shea, 2012) instead of being coddled.

Students strictly adhered to the tutors' feedback as absolute truths when an increased reliance on one-on-one tutors was observed to generate solutions for their designs (Green & Bonollo, 2003), which resulted in passive compliance (Webster, 2006). Learners' submission to authority was unknowingly ingrained into the studio culture as a tactic for peers to adapt. Master-apprentice students frequently defended against reviewing panels by expressing that the probed design features were directed by tutors, which reflected students' detachment from design ownership. One-on-one students might also realise the ineffectiveness of conforming strategies in the second semester due to the increased project subjectivities and complexities. As such, students' passive compliance results in mismatched expectations from design tutors, which could lead to increased confusion and anxiety. Students were expected to demonstrate greater autonomy and competency in respective works during the following semester after the induction period of the primer project in the first semester. Nevertheless, a lack of design progression would be observed due to passive compliance with design feedback could be misinterpreted as a lack of motivation to improve personal designs after being accustomed to the master-apprentice studio culture. Moreover, beginning design students might perceive tutors' comments as directives instead of general feedback. Hence, the higher anxiety experienced by one-on-one students in DP2 supported the notion that surface learners tended to be more anxious (Cipra & Müller-Hilke, 2019; Owen, 2016; Rozgonjuk et al., 2020) and academically underperforming compared to deep learners with higher levels of mental well-being (Owen, 2016).

Beginning design students in master-apprentice studios relied on passive compliance strategies for survival when advancing into senior years (Webster, 2006). A learner-centric environment in facilitating democratic or emerging ideas through participation would be ineffective when the authoritative learning atmosphere discouraged design discussions and design possibilities. Passively compliant students would also be more predisposed to adopt a surface learning approach, who share similar learning traits with learners focusing solely on excellent academic scores (Beattie et al., 1997) and strongly motivated by the fear of failure. Furthermore, one-on-one students might unconsciously induced into a culture of fear (Howlett Brown, 2022) by acceding to tutors' top-down feedback. Students would perceive that no alternative was provided when the master-apprentice tutor was the sole examiner of student grades, Subsequently, the student would choose to conform to prevent any jeopardy to future career prospects (Howlett Brown, 2022). Surface learners would also concentrate on attaining a minimum level of results (Beattie et al., 1997) and ensuring conformity instead of thoroughly comprehending and integrating different information. The learning characteristics relate to contemporary types of uncommitted students, who frequently seek to complete a course swiftly and effortlessly (Tay, 2021) while being more inclined to drop out (Liow, 2019).

RQ2 results: pedagogy and academic scores

Independent t-tests were conducted to determine statistically significant differences in students' academic scores between the two pedagogical groups. Paired t-tests were also conducted to examine the effects of pedagogical types on students' scores between DP1 and DP2. Specifically, CTL students' academic scores at DP1 (M = 73.98, SD = 5.73) outperformed one-on-one students (M=69.63, SD = 5.69) with a statistically significant difference (M = 4.67, 95% CI [-8.71 to -.002], $t(27) = -2.05$, $p = .025$, $d = -.76$) at a medium effect size. Similarly, the CTL students' academic scores at DP2 (M = 75.56, SD = 8.85) outperformed one-on-one students (M=63.13, SD = 15.11) with a statistically significant difference (M = 12.42, 95% CI [-21.78 to - 3.06], $t(20.68) = -2.68$, $p = .006$, $d = - 1.012$) at a large effect size.

The paired t-test discovered that CTL students' academic scores improved from DP1 (73.98, SD = 5.74) to DP2 (M = 75.56, SD = 8.86) without a statistically significant difference (M = 1.57 (SD = 7.980.620), $t(14) = - 0.764$, $p = .229$, $d = 0.20$) at a small effect size. Contrastingly, one-on-one students' academic scores decreased from DP1 (M=69.63, SD 5.68) to DP2 (M=63.13, SD 15.120) with a statistically significant difference (M = -6.50 (SD = 13.05), $t(13) = - 1.862$, $p = .043$, $d = - 0.49$) at a small effect size. As such, RQ2a and RQ2b were supported.

RQ2 discussion: pedagogy and academic scores

The current section expounds on a) the Generation Z CTL students' academic outperformance with the inclination to learn in a heterarchical collaborative environment and b) the TSR academic conversation model as the hidden curriculum for CTL students to mimic and cross-critique competently during self-initiated SSR peer-to-peer design discussions.

a) Generation Z students' proclivity to learn in a heterarchical collaborative environment

The CTL students' higher academic performance supported past researchers' assertions that first-year students with established social networks tended to demonstrate positive associations with academic achievement (Lisa et al., 2010; Masten & Coatsworth, 1998; Meehan & Howells, 2018, 2019; Strolin-Goltzman et al., 2016; Wyman et al., 1999; Yazedjian et al., 2007). The consistent performance of beginning CTL design students compared to master-apprentice peers (Liow, 2019; Liow, 2020, 2021a; Liow, 2022) postulated that Generation Z learners highly preferred the heterarchical cross-pollinative studio culture. Generation Z students' independent approach to information acquisition and exploration would be challenging in the conformity-governed and hierarchical master-apprentice learning process. Generation Z students' aversion toward hierarchical relationships or organizations (Katz et al., 2022) was also discovered in business pedagogies (Arar & Yüksel, 2015; Bieleń & Kubiczek, 2020), which was consistent with Sladek and Grabinger's (2014) argument that Generation Z students' indifference to authority is not an act of defiance but the willingness to collaborate.

The gap between Generation Z students' learning attributes was scarcely examined in the design studio pedagogical framework (Liow, 2021b). Educators' indifferent response could be due to perceptions that the studio was crowded with learners collaborating in a purportedly learning collaborative environment. The tutor's archetypal perception of the design studio might not be valid and academically beneficial when students' socialisation in the studio solely revolves around informal SSR social topics. The efficacy of self-initiated cross-pollinative discussions was also limitedly researched despite students constantly discussing their designs and being inclined to raise closed-ended (rather than explorative open-ended) questions have limited the potential for the design process. Notably, beginning design students were more interested in the formal aesthetic qualities of the design and raised more questions about the preferences for visual qualities (Liow, 2021b), which might result in neglecting key design integrity issues. Thus, learners were not explicitly educated on the effective methods to ask exploratory questions as the dominant paradigm of the master-apprentice pedagogy is predicated on replication and mimicry. Master-apprentice tutors persisted in current positions of being more experienced and skilful in imparting knowledge through the implicit hidden curriculum (Argyris & Schön, 1974; Banham, 1990). The resultant 'mystery-as-mastery' (Argyris & Schön, 1974) asymmetrical power structures allowed tutors absolute control over the learning process, thereby constraining the collaborative and diverse design discourses. Generation Z students' design progress was also discussed individually without the involvement of peers in most master-apprentice studios. Tutors might not recognise the need to involve other students in design discussions when regarding students' works as individual endeavours.

Several architectural studio models, such as Research Studios, Participatory Design, and Interdisciplinary and Live Studios, have been conceived to recalibrate the skewed power dynamics in recent years. The outward social dynamics of the pedagogies do not constantly reflect constructive and collaborative dialogue (Liow, 2016). Students' propensities in the collaborative studios highly depend on the tutor's active encouragement of participation in creating a safe environment for academic discussions. The pervasive modus operandi allows students to deliberately divide the assignment and

incoherently assemble completed parts for submission even when group or teamwork is required for site analysis or case studies. As such, tutors and students might choose not to expend effort after realising that time-consuming cross-pollinating discussions would not aid the project progress. The master-apprentice tutors completely control the length and trajectory of the discussions, thereby leading to a mismatch with Generation Z students' learning preferences that contributes to underperformance and increased anxiety. Nevertheless, external factors, such as the widespread reduction of studio hours (Tucker, 2016; Wallis & Williams, 2012) and the increased tutor-to-student ratio (Liow, 2016), might also contribute to the top-down educational approach. Students filled the gaps of reduced contact hours by conducting self-initiated design discussions without tutors' facilitation. Accordingly, leveraging the positive enculturation of the CTL studio culture could allow students to develop competencies and confidence in cross-pollinating and self-directed design discussions.

b) The CTL potentially improves the efficacy of learners' self-directed cross-pollinative P2P design discussions outside studio hours

Global trends of reduced studio hours resulted in design tutors providing less design feedback for more prescriptive or dictative approaches. The decreased studio engagement emerged as a learning gap for Generation Z learners with the drive for academic success that demanded instantaneous evaluations and feedback (Opriș & Cenușă, 2017; Sladek & Grabinger, 2014). Therefore, students were more predisposed to initiate cross-pollinative P2P design discussions outside studio hours among self-formed social support networks (Liow, 2019). The strong commitment to respective goals (Villa & Jason, 2017) amplified by the determination to seek change (Rue, 2018) catalysed the contribution toward collective efforts with less emphasis on personal recognition or reward (Katz et al., 2022). The efficacy of self-initiated SSR peer critiques also depended on students' design sensibilities and confidence. The CTL tutor's active engagement with learners to brainstorm and critique design issues during daily formative lessons could potentially resolve existing deficiencies. Moreover, CTL tutors' critiquing approaches to open-ended questions and providing specific, actionable feedback foster learners' camaraderie (SSR & TSR) as keystones in reproducing the cross-pollinative conversational models during students' self-initiated P2P discussions. Concurrently, the response time for design feedback decreases as peer learners collaborate toward improving respective designs when students become more receptive to receiving and synthesising alternative viewpoints, which would result in the consistently higher academic performance of CTL students over master-apprentice students. The decline in academic scores of one-on-one students also suggested that peer-initiated cross-pollination efforts were faced with challenged when unguided (Ghassan & Bohemia, 2015). The overreliance on the master-apprentice tutor for design resolutions arose from the strict compliance with instructive design feedback, which provided limited exposure to alternative design viewpoints when the sources of criticism, suggestions, and knowledge stem solely from the master tutor.

Limitations and future directions

Several limitations existed as this study was contextualised in a collectivist society, in which learners were more culturally inclined to collaborate. The CTL pedagogy might encounter initial resistance when being implemented in individualist countries, although most studies conducted in individualistic Western settings supported Generation Z students' tendency to work and socialise together. The inherent receptiveness of beginning design students without preconceived notions about studio pedagogy could also be leveraged without highly revamping the existing nature of assignments and curriculum when tutors initiate the CTL journey. As such, the student's peers remain consistent throughout the academic year as relationship building in the form of social support requires an extended period for CTL to operationalise. Meanwhile, the insignificant increase in student anxiety levels was unexpected considering that most studies supported the positive effects of social support on anxiety. Inferential statistics-based validations could offer a positivist view of reality as the inferred findings remained speculative. Furthermore, students generally report negative self-evaluations in Asian countries, where self-deprecation (Kwok & Lai, 1995) and humility are prevalent. Longitudinal studies should be conducted to collect additional data points for a more holistic understanding of the phenomenon. The CTL

tutors could also document respective observations in the studios and conduct students' focus groups for future work. Triangulating qualitative descriptions of students' lived experiences would assist researchers in accurately evaluating CTL pedagogical outcome measurements.

CONCLUSION

The present study emphasised the role of design pedagogy in promoting design literacy and explored the hidden curriculum of the one-on-one master-apprentice model. The traditional one-on-one pedagogical approach hinders the development of design literacy by focusing on conformity, replication, and transmission of the tutor's stylistic preferences. The master-apprentice studio pedagogy constricts the learning environment and perpetuates an oppressive learning environment, which is a continuous threat to students' mental well-being (Stead et al., 2022) throughout the decades (Braaten, 1964). The model is contrary to Nielsen and Brænne's (2013) advocation of the vital design educational role in promoting democratic ideals through participation and dialogue. Hence, this study highlighted the 'public success and private breakdown' phenomenon, wherein students might outwardly appear successful but privately struggle with the pressures and demands of the master-apprentice pedagogical approach. The fiasco at the highly regarded Bartlett School of Architecture (Howlett Brown, 2022) serves as a significant reminder of the detrimental effects produced by asymmetrical power structures. Therefore, the current study underscored the need for a recalibrated power-structured CTL studio pedagogy, which advocates for a supportive and inclusive learning environment that fosters collaboration and social support in creating a discourse that promotes design literacy without compromising students' mental well-being. Educators could also critically reevaluate the prevalent master-apprentice design studio model and embrace more equitable, inclusive, and collaborative pedagogies. A shift toward heterarchical design processes could empower students to engage in open discussions, critical thinking, and creative exploration, which assist in preparing students for the complexities and challenges of the 21st century with a rapidly evolving design landscape.

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