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Satisfying higher education students' psychological needs through case-based instruction for fostering creativity and entrepreneurship

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Designing effective strategies for developing higher education students' competencies, such as creativity and entrepreneurship, is crucial for their survival and self-realization in the technology-rich 21st century. This study is important as it addresses a significant research gap by designing and implementing self-determination theory (SDT)-guided case-based instruction (CBI) to enhance digital learners' creativity and entrepreneurship. A class of 34 master's students in a taught programme focused on digital learning and technology at a public university in Hong Kong participated in the study. First, the students took a pre-test to assess their creativity and entrepreneurship. They then experienced a 13-week course designed using SDT-guided CBI. After the intervention, they completed a post-test on their creativity and entrepreneurship. Additionally, the researchers conducted interviews with 10 participants. These processes allowed the researchers to evaluate the effectiveness of the SDT-guided CBI learning activities and to gather participants' suggestions for improving the design. The results of a repeated measures analysis of variance indicated the feasibility of SDT-guided CBI. Significant improvements in creativity were observed from the pre-test to the post-test, from the pre-test to the mid-test, and from the mid-test to the post-test. Meanwhile, students' entrepreneurship significantly increased from the pre-test to the post-test, although the increases from the pre-test to the mid-test and from the mid-test to the post-test were slight and did not reach a significant level. From the qualitative data, students provided suggestions such as selecting effective case studies, using entrepreneurs' stories, supporting entrepreneurial experiences, promoting technology-enhanced learning, and advocating for collaborative learning to improve the design. The findings imply that SDT-guided CBI has the potential to continually enhance students' creativity and entrepreneurship throughout its implementation, with significant opportunities for improvement based on the implementation experiences.

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Introduction

Learning and teaching practices in the 21st century are becoming increasingly complex and dynamic due to the rapid development of educational technologies (Olszewski & Crompton, 2020) and the adoption of innovative learning designs (Auernhammer & Roth, 2021). These complex and dynamic educational practices have led to new requirements for instructional designers, as effective learning activities should be designed to engage students, enhance their understanding, and equip them with the diverse skills necessary for their future survival and self-realisation (Vahlo et al., 2023; Weng et al., 2022c). Even more challenging, these learning designs are expected to fit into different learning contexts and subjects (Alani, 2020; Beck et al., 2023; Rajabalee & Santally, 2021). For example, one challenge could be in designing appropriate learning activities to foster higher education students' creativity and entrepreneurship skills (Agarwal et al., 2020; Drakpa et al., 2024; Hasani et al., 2023; Salamzadeh et al., 2014; Salamzadeh et al., 2022; Wannamakok and Liang, 2019).

Diverse instructional strategies have been designed to foster student learning (Wijnia et al., 2024). Among them, case-based instruction (CBI) is regarded as promising, particularly in business, medicine, and education subjects (Nguyen & Tull, 2022; Sisternans, 2020). Researchers have reported some possible benefits of applying CBI, including increasing student engagement and motivation (Sisternans, 2020; Wijnia et al., 2024), gaining a deeper understanding of the subject matter (Sartania et al., 2022), enhancing critical thinking skills (Chang et al., 2020), and improving authentic problem-solving skills (Koehler et al., 2022). Despite the possible benefits of CBI, its effective application requires understanding students' underlying psychological needs during the learning process (Desmet & Fokkinga, 2020). As a widely recognised framework within psychology, self-determination theory (SDT) advocates that satisfying the psychological needs for autonomy, competence, and relatedness is essential for developing individuals' motivation, performance, and overall well-being (Deci & Ryan, 2000; Ryan & Deci, 2000). SDT has profound implications for designing engaging learning environments; therefore, many educators have adopted it to guide their instructional strategies, with positive learning outcomes reported (Guay, 2022; Vasconcellos et al., 2020; Weng et al., 2022b).

While the possible benefits of CBI and the insights provided by SDT are recognised, few scholars have explored the combination of these two strategies, particularly in the context of developing creativity and entrepreneurship among higher education digital learners who primarily learn using digital platforms. This research gap highlights the need for a study that investigates how SDT-guided CBI impacts student creativity and entrepreneurship, and how the combined instructional strategies can be enhanced to foster these learning outcomes. Our study aims to address this knowledge gap by incorporating the insights from SDT into the practical application of CBI. This study utilizes SDT and CBI as two theoretical frameworks to design learning activities and explore the combined instructional effects on developing higher education digital learners' creativity and entrepreneurship. From a pedagogical perspective, CBI highlights the importance of real-world context as a strategy for enhancing student learning. From a psychological perspective, SDT emphasizes the significance of satisfying students' basic psychological needs for autonomy, competence, and relatedness to foster engagement and creativity. By combining the two frameworks, the learning activities are contextualized and informed by the principles of SDT. Among the three main areas of the journal *Humanities & Social Sciences Communications* (i.e., humanities, behavioural sciences, and social sciences), our study falls in the

research stream of social sciences, particularly in the discipline of education. Our paper advances the research by contributing to the literature on effective instructional design and providing valuable insights for instructional designers in the context of fostering creativity and entrepreneurship in higher education.

Literature review

Satisfying students' psychological needs for creativity and entrepreneurship. The three psychological needs described by SDT highlight the importance of scaffolding students' autonomy, competence, and relatedness to improve their learning outcomes (Chiu, 2024; Deci & Ryan, 2000; Ryan & Deci, 2000; Xia et al., 2022). The universality of these needs is a key tenet of SDT, suggesting that these needs are consistent across various contexts, including creativity and entrepreneurship. The first need, autonomy, refers to feeling a sense of choice, willingness, and free will in one's actions (Guay, 2022). The satisfaction of autonomy enables students to perceive themselves as the initiators of their actions and behave in a way that matches their interests and values (Ryan and Deci, 2000). Autonomy is essential in the context of developing creativity and entrepreneurship because it allows individuals to freely exercise their creative capabilities, think outside the box, and take calculated risks without fear of external judgement or control. Empirical studies have demonstrated the positive relationship between autonomy and creative competencies (Aldosari & Alsager, 2023; Burcharth et al., 2017), suggesting that when individuals feel autonomous, they are more likely to generate novel and useful ideas.

The second psychological need, competence, concerns individuals' ability to interact effectively with their learning environment and achieve a sense of effectiveness, mastery, and skilfulness (Orkibi & Ronen, 2017). Competence encourages students to pursue challenges that may slightly exceed their current abilities and engage in activities that will ultimately improve their skills (Guay, 2022). Competence is beneficial in the entrepreneurial context, as it highlights the confidence and ability to transform creative ideas into viable entrepreneurial endeavours. Authentically, entrepreneurs need to feel competent in their ability to navigate complex and changeable business situations (Weng et al., 2022a). Research has demonstrated the positive influence of perceived competence on entrepreneurial performance (Ng et al., 2016; Oo et al., 2022).

The third psychological need, relatedness, involves a sense of connection and belonging with others (Ryan & Deci, 2017). This need for relatedness drives students to communicate efficiently and harmoniously with their peers in the collective (Guay, 2022). Relatedness is critical for creativity and entrepreneurship development, as innovation often thrives in collaborative environments (Chi et al., 2018), and businesses require support networks to succeed (Spiegel et al., 2016). Meanwhile, entrepreneurs need to feel a sense of relatedness to their team, customers, and the broader business community to sustain their entrepreneurial intentions in the face of challenges (Neneh, 2022). Entrepreneurs who foster strong relationships are more likely to succeed, as they can leverage these relationships to obtain support, feedback, and new opportunities (Klotz et al., 2014; Martinez and Aldrich, 2011).

By satisfying their psychological needs for autonomy, competence, and relatedness, students can unlock their creative potential and increase their chances of entrepreneurial success. Backed by extensive research, the SDT framework offers instructional insights for nurturing creativity and entrepreneurship, and contributes significantly to student well-being and broader economic growth.

CBI for creativity and entrepreneurship. CBI, also referred to as case-based learning or case-based teaching (Wu et al., 2023), uses 'cases', or real-world scenarios, to provide bridges between theoretical knowledge and practical applications (Lyons & Bandura, 2020; Zhao et al., 2020). Case studies can provide rich and contextual insights into complicated situations. They are also effective in helping to understand the applications of theoretical frameworks in the real world. Conducting case studies using CBI enables students to learn from real-world examples and encourages them to apply their knowledge in practical contexts (Sistermans, 2020; Zhao et al., 2020). According to Yin (2009), these case studies can be classified into explanatory, exploratory, and descriptive types. In its diverse forms, CBI is regarded as a potential approach for students' creativity and entrepreneurship (Luo et al., 2018; Zotov et al., 2021).

CBI fosters an environment conducive to creativity through encouraging active learning, collaboration, and student engagement (Davies et al., 2013; Sartania et al., 2022; Zhang et al., 2023). It provides prototype strategies that represent theories or principles in addition to facilitating situations where students may practice their problem-solving and decision-making skills (Luo et al., 2018). The students must dissect the case studies, identify the underlying issues, and generate potential solutions (Lavi & Marti, 2023). Hence, the students think beyond the given information, make connections between information, and propose innovative solutions. Some researchers have proved the feasibility of CBI in fostering creativity. For example, after conducting a formative research study that applied the case-based method to design self-directed online instruction, Luo et al. (2018) revealed the potential of this method in inspiring innovation and creativity. Moreover, Novalinda et al. (2023) reported that their flipped learning integrated problem-based and case method design improved students' creativity skills in clinical refraction courses, while Vani et al. (2022) showed that student-designed cases in biochemistry fostered their creative skills.

Regarding entrepreneurship development, CBI exposes students to real-life entrepreneurial dilemmas and decisions, thus providing a valuable, practical complement to the knowledge they gain from the classroom (Lusoli, 2020). This immersion into the world of entrepreneurship allows students to grasp not just the experience of running a business, but also the risks, responsibilities, and resilience it demands, thereby shaping the attributes that are essential for successful entrepreneurs (Boldureanu et al., 2020). Some researchers have investigated the adoption of CBI in fostering entrepreneurship skills. For instance, Abd Rahim et al. (2022) reported that CBI is effective in developing students' entrepreneurial self-efficacy and opportunity recognition. Similarly, Musara (2024) proved that the case study method in entrepreneurship education contributes effectively to entrepreneurial self-efficacy in several ways, including sparking entrepreneurial motivation, promoting entrepreneurial career growth, and serving as a source of inspiration. Additionally, Zotov et al. (2021) conducted a quasi-experimental study to assess the impact of case studies on the performance and entrepreneurial success of university economics students. The researchers demonstrated that the use of case studies can benefit graduates' career development in an entrepreneurial environment.

Essentially, the evidence supporting the effectiveness of CBI highlights its potential to foster creativity and entrepreneurship skills, and thereby cultivate future creative entrepreneurs.

CBI and psychological needs. Given their connotations, potential convergence and complementarity may exist between CBI and the three psychological needs of SDT. For instance, CBI allows students to exercise their judgement, make decisions, and take

responsibility for their learning outcomes, thereby enhancing their sense of autonomy (Luo et al., 2018). Meanwhile, as students progressively solve cases, they develop confidence in their abilities, which enhances their sense of competence (Alrashidi et al., 2023). Furthermore, CBI often involves group work. While collaborating to analyse cases and develop solutions, students foster relationships with their peers, thereby satisfying their need for relatedness (Koehler et al., 2022).

Despite these potential overlaps, earlier researchers did not connect CBI with students' three psychological needs in their instructional practices, even though some have investigated the interaction between CBI and student motivation (Raza et al., 2020; Wijnia et al., 2024). A limited number of studies have shown the effectiveness of integrating CBI with SDT to foster learning outcomes in creativity and entrepreneurship for higher education digital learners. The education field would benefit from further relevant studies.

Methods

As reviewed above, integrating CBI and SDT into learning activities may foster diverse interactions for digital learners. Engaging with learning tasks and individuals within the learning environment can promote positive psychological experiences and lead to improved cognitive learning outcomes. Therefore, a composite instructional design that caters to students' psychological needs shows great promise. However, how to integrate CBI and SDT to facilitate the development of creativity and entrepreneurship remains underexplored. This study aimed to understand how the integration of SDT into CBI cultivates creativity and entrepreneurship among higher education digital learners over time. In this study, we refer to this integration as SDT-guided CBI. Our findings are expected to contribute to CBI instructional designs by adding a needs satisfaction component. Hence, our two research questions (RQs) are as follows:

RQ1: How does SDT-guided CBI foster higher education digital learners' creativity and entrepreneurship over time?

RQ2: From the perspective of SDT, what are some design considerations for CBI?

This study adopted a mixed-methods approach to answer these two RQs. To answer RQ1, we used a questionnaire related to creativity and entrepreneurship to investigate how SDT-guided CBI changed how the students perceived creativity and entrepreneurship. To answer RQ2, we used semi-structured interviews to collect the students' views on the instructional design. Students take a pre-test before the intervention. After the intervention, they complete a post-test. Following that, the researchers interview some students. This process allows the researchers to examine the effectiveness of the SDT-guided CBI learning activities and collect participants' suggestions for improving the design.

Research context and learning design. This research study was implemented in a public university in Hong Kong during the 2023/24 academic year. The 34 participants were master's students in a taught programme focused on digital learning and technology. The instructional strategies were designed for the Apply Digital Technologies to Diverse Disciplines and Contexts course, which adopted a blended learning mode. The study was collaboratively designed by four researchers specialising in SDT, educational technology, youth development, and entrepreneurship education, respectively, with the aim to enhance students' strategic analysis of the applications of digital technologies across various contexts and organisations, in addition to cultivating their creativity and entrepreneurship. We obtained the students' informed consent before conducting the study.

Table 1 Scale characteristics.

Competency	Variable	Pre-test Cronbach's α	Mid-test Cronbach's α	Post-test Cronbach's α
Creativity	Self/everyday	0.90	0.85	0.95
	Scholarly	0.84	0.91	0.93
	Performance	0.87	0.91	0.91
	Mechanical/scientific	0.91	0.95	0.95
Entrepreneurship	Artistic	0.83	0.87	0.93
	Orientation towards learning	0.89	0.93	0.95
	Socially and environmentally conscious conduct	0.91	0.96	0.97
	Market insight	0.86	0.90	0.93
	Seeing opportunities	0.93	0.95	0.97
	Building networks	0.85	0.95	0.96
	Ability to persuade	0.92	0.96	0.97
	Planning for the future	0.84	0.92	0.93
	Independence	0.84	0.85	0.94
	Decisiveness	0.88	0.90	0.96
	Awareness of potential returns	0.87	0.95	0.96
	Self-knowledge	0.86	0.90	0.93
	Perseverance	0.88	0.90	0.95

The Apply Digital Technologies to Diverse Disciplines and Contexts course consists of 13 3-h sessions conducted over consecutive 13 weeks (39 teaching hours in total). A range of learning activities, including knowledge preparation, case study analyses, hands-on digital making tasks, group challenges, and group presentations, were included in the course (see Appendix 1 for further details of these learning activities). All activities were connected with the students' psychological need for autonomy, competence, and relatedness from one or multiple perspectives. These activities gradually prepared students for their final group project, which involved conducting a case study on the digital application strategy of their chosen organisations in addition to an individual assignment that required the students to reflect critically on the digital experiences provided by these organisations.

Instruments. Student creativity was examined using the Kaufman Domains of Creativity Scale (KDCS), which was designed based on previous self-report creativity questionnaires (Kaufman, 2012). The validated KDCS has 50 items and five self-assessed creative behaviours (Table 1). According to the 50 items, the students must assess their creativity level by comparing themselves with peers who are of a similar age and have had similar life experiences for each of the activities mentioned. If they have not performed a particular activity, they can evaluate their potential creativity according to their performance in comparable tasks. The students graded themselves on a 5-point Likert scale (i.e. 1 = much less creativity and 5 = much more creativity).

Student entrepreneurship was evaluated using a multiple-choice questionnaire validated by Kyndt and Baert (2015), which was the result of a collaboration between various entrepreneurs and organisation sectors that support entrepreneurs. The questionnaire consists of 79 questions pertaining to 12 relevant competencies. Every item was responded to using a 6-point Likert scale (i.e. '1 = never', '2 = seldom', '3 = sometimes', '4 = often', '5 = most of the time', and '6 = always').

The study participants completed the creativity and entrepreneurship competency questionnaire at three time points (pre-test, before the CBI course; mid-test, in the middle of the designed course; and post-test, immediately after the course). The reliability of the variables was acceptable, with Cronbach's α values ≥ 0.7 (Taber, 2018; see Table 1).

Table 2 Student interviewees.

Interviewee	Gender	Age	Undergraduate major	Work experience level
1	M	26	Business	Intermediate
2	M	23	Language	Entry
3	F	23	Education	Entry
4	F	39	Education	Experienced
5	F	23	Language	Entry
6	F	23	Language	Entry
7	M	23	Technology	Entry
8	F	24	Language	Entry
9	F	42	Language	Experienced
10	M	23	Business	Entry

Semi-structured interviews. After the course was completed, we conducted semi-structured interviews with 10 students, each of which took 30–60 min. As demonstrated by various research studies (Brinkmann, 2014), this interview method merges a preset series of open-ended questions (e.g. questions that stimulate conversation) with opportunities for the interviewer to delve deeper into specific themes or responses. The guiding questions for the semi-structured interviews are presented in Appendix 2. The interview participant pool consists of 31 master's students who have completed all three tests. The interviewees were chosen based on discussions between the instructor and class representatives who observed the students' learning performance. The interviewees' basic characteristics are presented in Table 2.

Analyses. Quantitative data were used to answer RQ1. Specifically, one-way repeated measures analysis of variance (ANOVA) was adopted to compare the creativity and entrepreneurship competency questionnaire scores across the three time points between pre-test and mid-test, and mid-test and post-test. SPSS software (v. 24, IBM SPSS, Armonk, NY, USA) was used to facilitate the data analysis. Before the analysis, the normality of the data was examined using the Shapiro-Wilk test and QQ plot assessment. A p -value of 0.05 was used to represent statistical significance. Mean results were performed for each competency dimension.

Thematic analysis (Xu & Zammit, 2020) was used to analyse the interview data to answer RQ2 from the perspective of SDT. The first author first transcribed the interviews verbatim. She and

the second author, who has expertise in educational technology, then started coding the data according to the six stages of thematic analysis (Braun & Clarke, 2006), namely, understanding the data, formulating initial codes, searching for themes, scrutinising themes, identifying themes, and finally writing the report. Throughout each of the first five stages, the first two authors completed the tasks independently and held meetings with the last two authors to discuss and resolve any disagreements. For example, after the first and second authors familiarized themselves with the interviewees' words and formulated initial codes, they found that almost all interviewees shared their ideas about the cases provided for students in SDT-guided CBI. However, the two researchers discovered that participants had different opinions regarding which types of cases work well—some advocated for adopting successful entrepreneurial cases, while others preferred to avoid using distant, perfect cases. The researchers held meetings to review the themes and decided to categorize the statements into two suggestions: 'Selecting effective case studies,' which includes less-than-perfect cases, and 'Using entrepreneurs' stories,' which involves successful entrepreneurial narratives.

Results

This section presents the findings of the quantitative analysis on the feasibility of CBI for enhancing digital learners' creativity and entrepreneurship across three testing points. Additionally, it reports the qualitative findings regarding students' suggestions for enhancing the designed instruction strategy.

Descriptive statistics. Thirty-one digital learners finished all three tests. There were more female participants (71%) than male participants (29%). Table 3 shows the descriptive statistics for creativity and entrepreneurship competencies from the pre-, mid-, and post-tests.

Creativity changes in pre-, mid-, and post-tests (RQ1). A repeated measures ANOVA was performed to sequentially evaluate the changes in creativity at pre-, mid-, and post-tests. The results of Mauchly's test showed that the sphericity assumption was fulfilled ($\chi^2[2] = 3.49, p = 0.18 > 0.05$).

As shown in Table 4, the one-way repeated measures ANOVA indicated a significant difference between the effects of time on students' overall creativity ($F[2, 60] = 10.13, p < 0.001, np^2 = 0.25$).

Bonferroni post-hoc tests were performed on three paired sample comparisons (see Table 5). A significant increase in

Table 3 Descriptive statistics from the three tests.

Variables	Pre-test		Mid-test		Post-test	
	Mean	SD	Mean	SD	Mean	SD
Creativity	3.25	0.60	3.37	0.65	3.72	0.62
Entrepreneurship	3.88	0.70	4.02	0.80	4.29	0.89

creativity was observed between pre- and post-tests ($M = 3.25; M = 3.72, t = -0.47, p < 0.05$), and between mid- and post-tests ($M = 3.37; M = 3.72, t = -0.35, p < 0.05$).

Entrepreneurship changes in pre-, mid-, and post-tests (RQ2). A repeated measures ANOVA was performed to sequentially evaluate the changes in entrepreneurship at pre-, mid-, and post-tests. The results of Mauchly's test showed that the sphericity assumption was fulfilled ($\chi^2[2] = 5.52, p = 0.06 > 0.05$).

As shown in Table 6, the one-way repeated measures ANOVA indicated a significant difference between the effects of time on students' overall entrepreneurship ($F[2, 60] = 7.61, p < 0.05, np^2 = 0.20$).

Bonferroni post-hoc tests were performed on three paired sample comparisons (see Table 7). A significant increase in entrepreneurship was observed between pre- and post-tests ($M = 3.88; M = 4.29, t = -0.413, p < 0.05$).

Student considerations for SDT-guided CBI (RQ2). The students proposed various suggestions for using SDT-guided CBI to foster digital learners' creativity and entrepreneurship in higher education, including selecting effective case studies, using entrepreneurs' stories, supporting entrepreneurial experiences, promoting technology-enhanced learning, and advocating for collaborative learning. The following results show how each suggestion fostered their SDT needs.

Selecting effective case studies. Sixty percent of the participants suggested providing open-ended and imperfect case studies to allow more autonomy in creativity. For example, Student 3 observed that:

If the aim is to stimulate creativity, firstly, for the original case, students should feel that there are areas that can be improved ... If there are technical issues in the original case, it could potentially stimulate the students' creativity.

Similarly, Student 5 said, 'I believe that in the selection of cases, [the teachers] should choose more open-ended cases with multiple potential solutions, allowing students to express their innovative ideas'. Likewise, Student 2 observed that, 'we propose improvements, or what we call solutions, to a particular company.

Table 5 Pairwise comparison of entrepreneurship.

(I) Time	(J) Time	Mean Difference (I – J)	Std. Error	Sig. ^a
1	2	-0.13	0.11	0.760
	3	-0.47*	0.12	0.002
	1	0.13	0.11	0.760
3	1	-0.35*	0.09	0.002
	2	0.47*	0.12	0.002
2	1	0.35*	0.09	0.002

Based on estimated marginal means. *The mean difference is significant at the 0.05 level.

^aBonferroni adjustment for multiple comparisons.

Table 4 Within-subject effects of creativity.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial η^2
Time	Sphericity assumed	3.69	1.84	10.13	0.000	0.25
Error (time)	Sphericity assumed	10.92	0.18			

*Computed using $\alpha = 0.05$.

Table 6 Within-subject effects of entrepreneurship.

Source	Type III Sum of Squares		df	Mean Square	F	Sig.	Partial η^2
Time	Sphericity assumed	2.73	2	1.37	7.61	0.001	0.20
Error (time)	Sphericity assumed	10.76	60	0.18			

*Computed using $\alpha = 0.05$.

Table 7 Pairwise comparison of entrepreneurship.

(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig. ^a
1	2	-0.14	0.08	0.302
	3	-0.41*	0.12	0.003
2	1	0.14	0.08	0.302
	3	-0.27	0.12	0.096
3	1	0.41*	0.12	0.003
	2	0.27	0.12	0.096

Based on estimated marginal means. *The mean difference is significant at the 0.05 level.

^aBonferroni adjustment for multiple comparisons.

This suggestion requires us to use our imagination and creativity to come up with such a solution'. In addition, Student 4 provided details on dealing with open-ended case studies:

In terms of case analysis, students are encouraged to think about the case and incorporate their own ideas. For instance, how to optimise a marketing plan under certain circumstances in a company. Using divergent thinking to guide students, how can we optimise the timeline of the marketing plan? Can we optimise the plan through a low situation or other methods? Or, are the platforms used for multimedia promotion suitable for the target audience? Is there a better, newer platform or group? What platform do young people prefer? So, I believe creativity can be reflected from these aspects, which can optimise various aspects of our case analysis.

Three interviewees emphasised that the course could be improved by providing the latest case studies for students to meet their psychological need for relatedness, as shown by the following excerpts:

My understanding of CBI is that the most important aspect is to keep up with the times. Some cases may be outdated and not suitable for the current market. I think this is really important because you can't use cases from the 90's or the early 21st century to predict modern human behaviour and the current market. Things like TikTok are disruptive. If you still use the old materials for analysis, you definitely can't figure out the reasons. So, in my opinion, the newer the case, the better. (Student 1)

[Our course] includes the example of McDonald's using artificial intelligence and augmented reality technologies to train employees to fry chicken. Of course, I can say that it is an example that can inspire students' entrepreneurial spirit. The original example itself is very creative ... it is really happening, it aligns with technology, and it complies with tech trends. But to be honest, it is still an old case, because it feels like some news I saw about 2 years ago. If you look at the current situation, including the upcoming launch of Apple's new Version Pro, [change is] happening every day. (Student 7)

Moreover, some students highlighted the value of studying small and medium-sized companies for constructing relatedness among the students. For example, Student 4 observed that:

As business all begins from something small, our cases can be more down-to-earth or smaller ones, which don't require high startup funds, to better help students 'take the first step'. Big companies might make people feel it's unachievable, too far away from them.

Student 10 expressed a similar idea:

If we talk about large companies, their growth and development may not be particularly relevant to ordinary people. Because, if an ordinary person wants to start a business, they need to start small and grow step by step. So, I think that if we want to foster an entrepreneurial spirit, the best examples would be ordinary people's cases, starting perhaps with a small restaurant and gradually growing. A couple could start a small restaurant and then gradually expand and open a chain. Those cases might be more realistic and practical.

Using entrepreneurs' stories. The students proposed using entrepreneurs' stories as a strategy to foster learning. This method boosts the students' relatedness with the cases, enhancing their learning engagement and understanding. For instance, Student 2 proposed that:

If I were the teacher preparing the learning materials, I would investigate the experiences of some famous entrepreneurs. I would start by finding relevant cases from news media, such as Forbes. I would research when they started their business, what they initially did, what companies they created, and how they made so much money. Then, I would create a case study around this ... [so that students can learn] from the success stories of these accomplished individuals and draw lessons from their experiences.

Student 8 also suggested that:

I may find some successful entrepreneurial cases for students to understand the experiences and stories of these entrepreneurs. I believe that the entrepreneurial spirit of successful entrepreneurs, their entrepreneurial background, their journey, and the factors that contributed to their success can all inspire students. Therefore, I wouldn't likely choose a case of business failure for the students. Rather, I might lean towards successful entrepreneurial cases for the students to analyse. In the process of this analysis, students would learn about the background, process, and factors of successful entrepreneurship.

The students were also inspired by online resources for entrepreneurial stories. For example, Student 6 mentioned online bloggers:

I've seen many online bloggers share their entrepreneurial experiences. In a classroom setting, [the teacher] could

invite entrepreneurs who are part of a startup team or who have already succeeded. They can be at various stages of entrepreneurship. They could serve as guest lecturers and share their experiences with the students.

Meanwhile, Student 10 suggested using edited documentary footage to present entrepreneurial stories:

I've seen a series of online videos before. That series of videos specifically focused on successful entrepreneurs and how they've climbed from the bottom to their current heights step by step. When I watched it, I felt pumped, ha-ha. It really stirred up my spirits. These materials can be shared with everyone. All these materials can be clipped from the Internet, thus significantly reducing the duration to about 20 to 30 min, which is quite good and presents the content completely. The entrepreneurs may come from different industries. This might inspire everyone's entrepreneurial spirit.

Supporting entrepreneurial experiences. Seven students suggested providing opportunities for virtual entrepreneurial experiences to enhance their psychological need for relatedness. Some interviewees encouraged using the students' imagination to construct these experiences, as Student 2 commented:

I might ask the students to write an essay, where they imagine they've just won a lottery of 1 million. They are to outline how they would use this 1 million to become a successful entrepreneur or to make successful investments. They need to discuss which industries they would invest in and what they would do with this money ... For instance, they could invest the 1 million in McDonald's or use the 1 million to invest in Luckin Coffee. The students can then use their imagination to explain why they would invest in a particular industry, including what they find appealing about it, and then elaborate on these points in an essay.

Similarly, Student 4 proposed creating case studies to improve student creativity:

I think another method might involve allowing students to create cases based on their interests. Each student has their own dream job or dream company, or ideas for their own business. Currently, I haven't done this, but I could hypothetically create a case study. For example, I could imagine that I'm opening a flower shop, which is my ideal business. Originally, we were supposed to analyse existing real-world cases. However, to enhance creativity, we could allow students to create their own case studies. They could then analyse and optimise these self-created case studies for a second time.

Further, the interviewees provided different possibilities for running a virtual company to fulfil the students' need for competence. For example, Student 1 recommended starting a hypothetical company:

You [the students] can start a company, theoretically, of course, and then you must prepare your cash flow statement and your balance sheet. Similar to a business course, you must properly prepare all these tables. Then they should be reasonable, the numbers in them, and your turnover rate all must make sense, it's complicated, you can't just make up numbers ... For example, I was running a flower shop, and then you have to think about where your shop is located, how much is the monthly rent, how much is the cost, what is the passenger flow, what is your daily cash flow, and then they will also discuss things like your

posters, the taxes you have to pay, the type of wear and tear you have to account for, you have to calculate everything.

Moreover, Student 5 proposed providing simulated entrepreneurship projects for students to execute:

We can provide case studies for students to discuss while designing some simulated entrepreneurship projects. This can help cultivate their decision-making skills through implementing these virtual entrepreneurship projects. It can also enhance their leadership and confidence, and promote their team collaboration skills, among other things.

In addition, the students highlighted the importance of having authentic entrepreneurial experiences, as discussed by Student 6:

If I were to use the case study teaching method, I believe I would guide the students directly into an actual business environment. They could experience the case in a real-life scenario or imitate a simple project based on a case study. They could achieve tangible results, such as creating some income, or experiencing the process of creation. In this way, they may gain a deeper understanding and creativity may emerge in the process.

Promoting technology-enhanced learning. Some participants emphasised that technologies enable more diverse ways of expression and can facilitate more engaging learning experiences, which satisfied the students' psychological need for competence and autonomy. For example, Student 1 believed that 'in education, we need to have some new technological perspectives. Only then can we come up with, and express, many new ideas'. Student 1 continued in this vein:

[In our course], we can use some technological methods to enhance the presentation of the case ... Honestly, if you're thinking about something like a Metaverse classroom in the future, or any kind of Metaverse-based education, it's essentially about providing a faster and more vivid case solution for students learning in the Metaverse ... Because the Metaverse may provide a more convenient environment for teachers in the classroom, it could allow them to demonstrate larger or more tangible objects.

Student 10 highlighted the advantage of technologies in facilitating immersive learning experiences, which promoted the students' need for relatedness:

Let me think for a moment and put myself in the teacher's role, to improve the CBI. My thoughts might be a bit out of the box, because our current learning activities are mainly in the classroom. Yes, my idea is that if we could organise some workshops, some hands-on activities that allow students to personally experience and get involved, this experience doesn't necessarily mean you have to complete a certain task. It could also be combined with our digital technology to experience some games. Because there are some games that are similar to the Monopoly game, where each person is a unique character. Yes, and then you can do whatever you want within the character's capabilities. It's somewhat similar, but it is implemented via a computer.

Advocating for collaborative learning. Some students advocated using collaborative learning approaches to foster learners' creativity and entrepreneurship. Communication and discussion among peers provided the students with opportunities to exchange thoughts, broaden their horizons, and enhance their

Table 8 Suggestions for instruction improvements according to the three psychological needs.

	Autonomy	Competence	Relatedness
Selecting effective case studies	Open-ended and imperfect cases		Latest cases Small and medium-sized companies Experiences of some famous entrepreneurs Online resources for entrepreneurial stories Imagination to construct virtual entrepreneurial experiences Visiting actual business environment Immersive learning experience
Using entrepreneurs' stories		Running a virtual company	
Supporting entrepreneurial experiences			
Promoting technology-enhanced learning	Diverse ways of expression	Diverse ways of expression	
Advocating for collaborative learning		Communication and discussion among peers Collaborative model	Communication and discussion among peers

ideas. Therefore, the collaborative learning approach improved students' psychological needs for competence and relatedness. As elaborated by Student 8, 'it [the class] could involve allowing students to work in groups, encouraging them to think collaboratively. Then, they can use their collective thoughts to tackle the entrepreneurship case studies'. Student 5 had a similar recommendation, 'I would facilitate students' group discussions or presentations, providing them enough time to think and express their thoughts within their teams. During this process, I may offer some guidance as needed'.

Further, Student 1 described his suggestions on the division of labour while finishing tasks as a collaborative team:

If you are in a group, you definitely need to choose a group leader, right? The group leader doesn't necessarily have to do specific tasks. If the leader is engaged in specific tasks, and everyone is doing the same, then no one is there to tie everything together. Because the specific tasks are simple and straightforward, everyone can do the work if they spend time, right? Everyone can handle the data, but the challenging part is how to connect the data coherently. Because you need to consider the logic, you need to think and you need to focus on whether it's consistent from beginning to end. The group leader, I think, should focus more on tying together different modules.

Student 1 summarised the main issue with CBI:

CBI, I think it's fine, no problem. But if it involves a lot of elements [for improvement], it actually doesn't matter, because the focus isn't on the format. The key lies in the elements I mentioned earlier—there should be a collaborative model.

The students' overall suggestions are summarised in Table 8.

Discussion

Creativity and entrepreneurship changes in SDT-guided CBI design. In response to RQ1, the statistical findings demonstrated a significant rise in overall creativity throughout the design. Significant improvements were observed from the pre-test to the post-test, from the pre-test to the mid-test, and from the mid-test to the post-test. These results align with earlier studies that explored students' development of creativity in the context of CBI (Novalinda et al., 2023; Vani et al., 2022). The designed SDT-guided CBI provides a lens to further elaborate on the mechanism of students' creativity development. Luo et al. (2018) proposed that CBI provides learning occasions for students. Hence, our design allowed the students to select any case study they liked and then analyse the target case based on the information they collected. This initiative can be beneficial in satisfying students'

psychological need for autonomy and relatedness. Moreover, it was previously highlighted that CBI advocates problem-solving and requires students' innovative solutions for cases (Lavi & Marti, 2023). Our design encourages students to describe and explain the cases (Yin, 2009) with reference to solid international standards or benchmarks. By providing this scaffolding, the learning tasks meet students' psychological need for competence.

Additionally, our statistical results showed that students' entrepreneurship significantly increased from pre- to post-test, although the increases from the pre- to mid-test and the mid- to post-test were slight and did not reach a significant level. These findings confirmed earlier studies indicating that the adoption of CBI can enhance students' entrepreneurship skills (Abd Rahim et al., 2022; Musara, 2024). The design of SDT-guided CBI further promotes this skill enhancement by highlighting the possible satisfaction of psychological needs in the learning process. Similarly to Boldureanu et al. (2020) and Lusoli (2020), who suggested that CBI provides students with real-world contexts for entrepreneurial behaviours, our designed course stimulated higher education digital learners to reflect strategically on the digital applications of companies or organisations. By encouraging the students to adopt an entrepreneurial mindset, the SDT-guided CBI design fulfilled students' psychological needs for competence and relatedness.

The changing paths for these two skills indicate that SDT-guided CBI had a greater impact on students' creativity than on entrepreneurship. This result could be because entrepreneurship, which is a personal trait that involves both individual and environmental factors (Thomassen et al., 2020), is a genuine practice in the business profession. In addition, the students may not have had sufficient opportunity to obtain first-hand entrepreneurial experience during their academic years and in our designed course.

Design consideration for enhancing SDT-guided CBI. In response to RQ2, we collected the students' suggestions on how to improve our instructional design, which were all based on the students' initial experience with the SDT-guided CBI course. The course was designed to fulfil the students' psychological needs for autonomy, competence, and relatedness in the learning process (Deci & Ryan, 2000; Ryan & Deci, 2000). The interactions between these suggestions and the three psychological needs are illustrated in Fig. 1.

The students proposed that future efforts should be made to select effective case studies for SDT-guided CBI courses (Lyons & Bandura, 2020; Wu et al., 2023; Zhao et al., 2020). Contrary to our common perception that the selected case studies should represent successful and influential cases, the students considered open-ended or imperfect cases, recent cases or cases representing

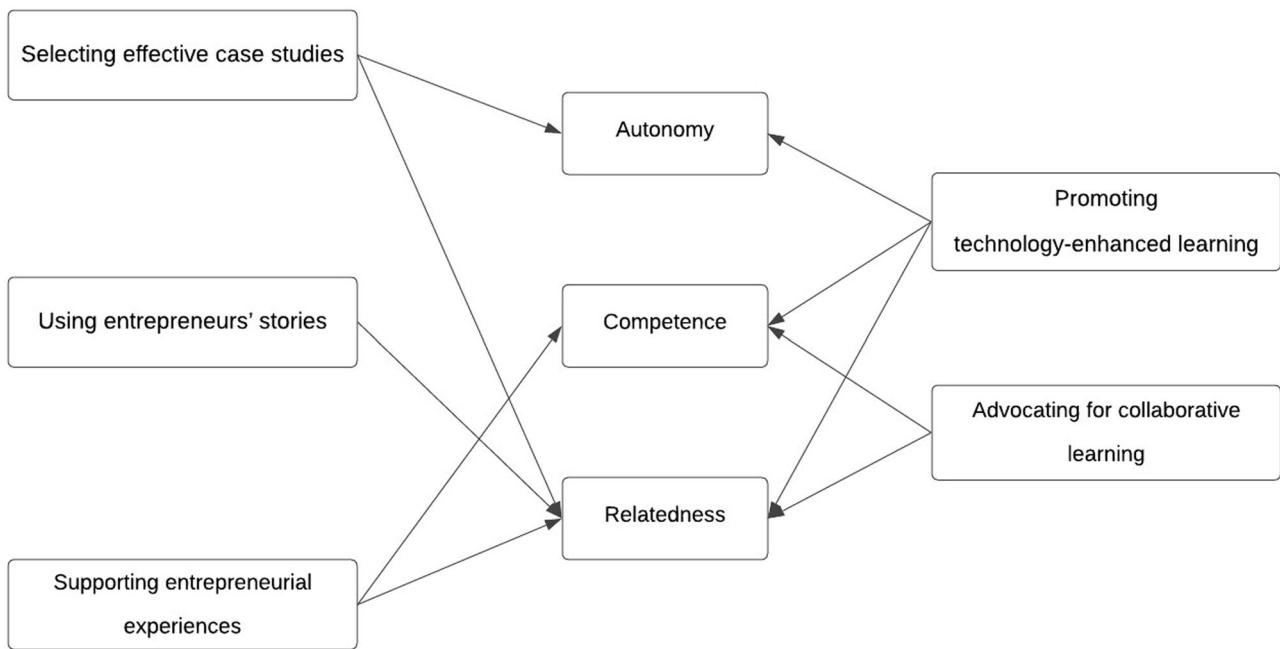


Fig. 1 Suggestions for instruction improvements according to the three psychological needs.

small and medium-sized companies as being more effective in cultivating their creativity and entrepreneurship. These proposals indicate that students feel stronger relatedness when the case is relevant to them, and they are provided with opportunities to improve on their designed solutions (Lavi & Marti, 2023). Future instructional designers are suggested to incorporate these insights into their subsequent practices.

Internet technologies were recommended as vital tools for enhancing SDT-guided CBI courses in diverse ways. Potential technological applications for students include providing online resources for entrepreneurial stories, virtual entrepreneurial experiences, digital methods for expressing ideas and presenting case studies, and immersive learning experiences. Further, Internet technologies have shown their strength in satisfying all three psychological needs, instead of focusing on one or two psychological needs like the other suggested strategies. Depending on the learning objectives, different technologies are available for adoption (Tang et al., 2022). The recommendations that the highlighted technologies be consistent with contemporary trends, such as the development of educational technologies, including generative artificial intelligence (Chiu, 2023) and programming platforms for children (Weng et al., 2023), imply that technology-empowered instruction is emerging as a promising direction and is expected to experience considerable growth in the future.

Based on these collected suggestions, students' entrepreneurial experiences can be supported in both authentic and virtual ways. As mentioned previously, entrepreneurship requires a specific learning context (Thomassen et al., 2020). Virtual entrepreneurial experiences, whether they are derived from students' imaginative business project mock-ups or practicing the management of a virtual company, provide potential technological solutions for providing a learning context complementary to visiting authentic business environments. These strategies for providing virtual experiences make it possible to conduct entrepreneurship training in the classroom. Although the students did not mention it, another practice implication could involve incorporating small-scale business practices into curricula to provide learners with real-world business experiences. This is currently particularly relevant, as financial literacy was introduced as a primary

dimension in the Organisation for Economic Co-operation and Development's Programme for International Student Assessment (Salas-Velasco et al. 2021).

Furthermore, the students emphasised the importance of collaborative learning in enhancing creativity and entrepreneurship because it satisfied their psychological needs for competence and relatedness. The advantages of collaborative learning have been reported by previous studies (Ouyang, 2021; Qureshi et al., 2023); nevertheless, our study contributes to the literature by proposing that it is essential to design the collaborative learning environment strategically, instead of simply dividing the labour among group members. Collaborative strategies are a crucial consideration for instructional design (Deng et al., 2022; Supena et al., 2021); therefore, we recommend that instructional designers of future collaborative learning environments should be more creative when designing effective collaborative models.

Conclusion

To summarise, SDT and CBI are possible instructional strategies for fostering creativity and entrepreneurship among higher education digital learners. Combining these strategies could produce effective SDT-guided CBI experiences for students. Our study found that this innovative instruction has the potential to enhance students' creativity and entrepreneurship continually throughout its implementation. In addition, the students proposed some suggestions for how to improve the SDT-guided CBI further.

While our research enriches the literature on SDT-guided CBI, it is important to acknowledge three limitations. First, our research participants were master students in a digital learning programme. Given that students' backgrounds may influence their learning outcomes, it may not be accurate to extrapolate our findings to students from other domains. Future studies could investigate how SDT-guided CBI affects the learning outcomes of students from different domains. Second, this study aimed to understand how specific activities foster student learning by satisfying their SDT needs but did not explore their effects. Therefore, multi-group research designs should be used to examine the effects of the SDT-guided CBI activities on the

satisfaction of students' psychological needs. Third, we used a mixed-methods design in this study to examine the effects of SDT-guided CBI. We repeated our evaluations using pre-, mid-, and post-tests. The results demonstrated that students' creativity and entrepreneurship increased continually; however, it remains unclear whether these effects continued after completing the course. Future research should include delayed tests to further evaluate the on-going effectiveness of SDT-guided CBI in fostering students' creativity and entrepreneurship.

Data availability

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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Author contributions

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Competing interests

The authors declare no competing interests.

Ethical approval

Ethics approval was obtained from the Education University of Hong Kong. The approval body is the Human Research Ethics Committee (HREC) of the Education University of Hong Kong. We confirm that all research was performed in accordance with relevant guidelines/regulations applicable when human participants are involved. The approval number is 2022-2023-0531, and the date of approval is October 19, 2023. The scope of approval includes research in the course "Apply Digital Technologies to Diverse Disciplines and Contexts" at the Education University of Hong Kong. The project is titled "Developing Creativity and Entrepreneurship via Case-Based Learning for Higher Education Digital Learners."

Informed consent

Informed consent was obtained in the classroom at the Education University of Hong Kong. Written informed consent was obtained on October 25, 2023, by the first author from students in the course "Apply Digital Technologies to Diverse Disciplines and Contexts." The scope of the consent includes the introduction of the research and the student participants from the target course. The data collected will be used to reveal students' creativity and entrepreneurship development from the designed course. The participants consent to the possibility that the research results may be published in journal articles and conference presentations. The study does not involve vulnerable individuals, nor does it involve payment or other forms of incentivization. The study is interventional research.

Additional information

Supplementary information The online version contains supplementary material available at <https://doi.org/10.1057/s41599-025-04597-2>.

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