Bridging gaps and shaping futures: digital informal learning and the construction of possible selves in Chinese higher education

Zihao Liu[1], Jian Zhang[2]*, Chixiaofei Liu[2] and Qingwei He[2]

[1]University of Nottingham, Nottingham, United Kingdom, [2]Xi'an Eurasia University, Xi'an, China

Introduction: Digital informal learning (DIL) has become increasingly important in higher education, providing a flexible complement to traditional instruction and supporting students' academic and personal development. This study explores how Chinese university students engage with DIL through the lens of 'possible selves', examining how their envisioned identities motivate their informal learning behaviours.

Methods: A mixed-methods design was employed at a Chinese university, combining quantitative survey data from 514 undergraduate students with qualitative data from in-depth interviews with 18 participants. The survey assessed students' conceptual understanding, attitudes, and usage frequency of DIL, while interviews provided deeper insights into their motivations and experiences.

Results: Survey findings indicated that although students had limited conceptual knowledge of DIL, the majority recognised its significance and routinely integrated it into daily learning practices. Interview data further revealed that students predominantly utilised DIL to compensate for formal education shortcomings, such as limited classroom time, outdated materials, and insufficient teaching quality. Additionally, students' engagement with DIL was strongly influenced by their aspirations (ideal academic selves) and their fears of academic failure (feared selves), shaping DIL use as both a remedial strategy and a proactive measure for self-improvement.

Discussion: The findings underscore the dual role of DIL in addressing formal curriculum gaps and fostering self-directed personal growth, while also highlighting potential risks such as fragmented knowledge acquisition and information overload. The study extends the 'possible selves' theoretical framework into the digital learning context and offers practical implications for curriculum development, teacher professional development, and digital literacy initiatives. Ultimately, this research advances the understanding of leveraging digital learning innovations to create more responsive and equitable educational environments.

KEYWORDS

digital learning, informal learning, higher education, possible selves, China

Introduction

Informal learning is becoming increasingly important for learners of all ages (Selwyn, 2007). According to Attwell (2007), informal learning accounts for 80% of personal knowledge and skills acquisition. In higher education, learning that takes place in traditional educational scenarios or top-down training mechanisms is no longer the only essential pattern. Informal learning

empowers students by granting them autonomy in selecting the content and timing of their studies, which increases their engagement because the content is likely more applicable and interesting to them (Song and Bonk, 2016). Importantly, informal learning can support formal learning by filling gaps in formal curricula and contributing to a better understanding of formal learning content (Gramatakos and Lavau, 2019; Peeters et al., 2014). Informal learning assists students in developing information, abilities, and attitudes beyond the confines of the standard classroom or formal education setting (Gramatakos and Lavau, 2019). This supplement is crucial to the involvement of university students in professional development and personal advancement. Moreover, informal learning relies on a self-directed and student-centered approach, shifting the balance of agency from teacher to student (Cope and Kalantzis, 2017), providing students with more learning initiative.

The rapid evolution of digital technologies has transformed informal learning into a dynamic, innovative practice. Digital informal learning (DIL) leverages ubiquitous mobile devices and online platforms to create flexible, learner-centered environments that transcend traditional spatial and temporal boundaries. The development of digital technology is changing the way students learn both inside and outside the university, and engaging with digital technology is becoming a core part of students' daily life, with electronic tools, mobile devices, social networking environments and online learning becoming increasingly popular among college students (He et al., 2018). In China, Current informal digital learning activities among university students primarily include using learning software (47.1%), accessing learning materials (79.6%), browsing courseware (52.3%), and completing post-class assignments (48.5%) (Fan, 2014). With digital tools at their disposal, students can access a vast array of educational resources anytime and anywhere, thereby broadening their learning opportunities and enabling interactive, collaborative, and self-directed study (Peters and Romero, 2019). This digital shift not only enriches the learning experience but also promotes a more personalised approach to education. However, the transformation is not without its challenges. Critics argue that the proliferation of online content raises concerns over quality control, while the digital divide may exacerbate inequities among learners with differing levels of digital literacy. Moreover, the risk of information overload and superficial learning remains a significant issue, potentially undermining the depth of understanding that informal learning is meant to foster (Chan et al., 2015; Huang and Oh, 2016).

In addition to these challenges, the literature reveals that much of the research on DIL has been predominantly descriptive rather than critically analytical. While studies by Attwell (2007) and Selwyn (2007) have laid the groundwork by highlighting the significance of informal learning, and Song and Bonk (2016) have underscored its potential to supplement formal instruction, there remains a gap in understanding the underlying mechanisms and potential drawbacks when digital innovations are integrated into higher education. Recent discussions in the field point to the need for a critical examination of how DIL not only supports learning but may also inadvertently reinforce educational inequalities and compromise academic rigor (Peeters et al., 2014; Gramatakos and Lavau, 2019). This critical stance is further supported by emerging perspectives on digital transformation in education (Eraut, 2004; Watkins and Marsick, 2021), as well as by scholars who emphasise that technology-enhanced learning environments must be carefully designed to balance innovation with quality assurance (Siemens, 2005; Kirkwood and Price, 2014).

Moreover, the application of digital learning innovations in the Chinese higher education context adds another layer of complexity. While digital platforms are becoming increasingly pervasive, empirical investigations into the individual-level dynamics of DIL among Chinese university students remain limited. The majority of existing studies focus on the advantages of DIL, such as flexibility and cost-effectiveness without critically exploring its potential to disrupt traditional pedagogical practices or its implications for student self-regulation and digital equity.

Against this backdrop, this study adopts the "possible selves" framework (Markus and Nurius, 1986) to explore how Chinese university students perceive and engage with digital informal learning. By linking students' envisioned future identities with their present learning behaviours, the framework offers a nuanced perspective on both the empowering potential and the critical challenges of DIL. Based on the discussion above, the overall research question guiding this study is:

> How do Chinese university students critically perceive and navigate the opportunities and challenges of digital informal learning within the evolving landscape of digital learning innovations?

Literature review

Informal learning

Informal learning is broadly defined as any learning that occurs outside the confines of formal education and is deeply embedded in everyday experiences (Malcolm et al., 2003). It is characterised by learners' active engagement in setting learning goals, planning tasks, and evaluating their own progress in unstructured, experiential, and non-institutional contexts (Reardon, 2004). This self-directed process is not always consciously recognised by learners; however, it is instrumental in shaping skills, knowledge, and attitudes over time (Decius et al., 2024). Unlike formal education, which adheres to predetermined curricula and structured outcomes, informal learning embraces spontaneity, diversity, and contextuality (Livingstone, 1999, 2001; Slater, 2004). Researchers such as Marsick and Volpe (1999), and Watkins and Marsick (2021) have highlighted that informal learning, though often incidental, plays a crucial role in personal and professional development. Gilbert (2010) further emphasises that the responsibility for learning rests on the individual, suggesting that even when learners are not fully aware of the learning process, they remain actively engaged in acquiring new skills and knowledge.

Digital informal learning

The digital era has significantly transformed the landscape of informal learning, giving rise to what is now known as digital informal learning (DIL). DIL refers to learning experiences facilitated by digital technologies and the internet that occur outside traditional educational settings (He et al., 2021). This evolution is marked by the integration of metacognitive, cognitive, and social dimensions into learning processes, enabling individuals to tailor their learning experiences to suit personal needs (Huang and Oh, 2016; Rafatjoo et al., 2025). Digital platforms support a wide range of activities, from accessing multimedia content to participating in online communities,

thereby promoting knowledge diffusion through non-instructional social interactions (Sackey et al., 2015).

Digital informal learning environments offer unprecedented flexibility, allowing learners to access resources anytime and anywhere (Zakir et al., 2025). Studies by Ang et al. (2018), Barkati et al. (2024), and Jin et al. (2019) demonstrate that such flexibility not only broadens learning opportunities but also supports interactive and self-directed study. Moreover, platforms that facilitate digital informal learning create a media-rich context where learners can merge formal and informal knowledge, thus enhancing their overall academic performance (Greenhow and Lewin, 2016; Liu and Ma, 2024; Song and Lee, 2014; Ungerer, 2016). However, the shift towards digital learning is not without challenges. Critical issues such as the need for robust quality control, the potential for information overload, and the persistent digital divide are increasingly noted in the literature (Doleck et al., 2019; Mishra, 2020). These concerns prompt a critical re-examination of the assumption that increased access to digital resources automatically results in enhanced learning outcomes.

Research on digital informal learning in China

Research on digital informal learning in China has expanded significantly over the past decade, with approximately 200 studies addressing various dimensions of DIL. Early investigations primarily focused on the theoretical foundations, exploring the concepts, functions, and significance of digital informal learning (Ren, 2012; Zhang, 2014). Subsequent studies shifted towards resource development, including the design and implementation of digital learning platforms and the construction of supportive learning environments (Li et al., 2009; Liu and Ma, 2024; Liu et al., 2025; Wu and Wang, 2025). Practical applications have also been examined, with researchers developing informal learning models and conducting comprehensive reviews of teacher development and case studies (Gong, 2018; Liu, 2012; Liu and Wang, 2024; Peng, 2012).

Despite these contributions, the existing literature in China remains fragmented and largely descriptive. Most studies emphasise the supplementary role of DIL in higher education without offering systematic empirical evidence to elucidate the underlying mechanisms that drive effective digital learning or to address its potential limitations. This gap underscores the need for a more critical and theoretically informed approach to understanding how digital informal learning impacts student engagement and academic achievement.

Factors affecting digital informal learning

Engagement in digital informal learning is influenced by a complex interplay of internal and external factors. Internally, individual attributes such as age, educational background, digital competence, and behavioural intentions significantly impact engagement levels. Digital literacy, a multifaceted construct involving technical skills, cognitive abilities, and ethical understanding, is fundamental for effective navigation in digital learning environments (Ala-Mutka, 2011). Research by He and Zhu (2017) demonstrates that personal innovativeness positively influences the willingness to adopt digital learning tools; students who are more innovative tend to actively seek out new digital resources and engage more deeply in DIL activities.

According to the research, students' personal innovativeness and digital competence are mediated by their attitude toward DIL, especially in the Chinese context. All these personal factors demonstrated significant direct effects on students' engagement in DIL (He and Zhu, 2017). Highly innovative individuals are proactive in seeking information about novel concepts, leading to a more favorable attitude and inclination toward accepting technology. Previous research has indicated that personal innovativeness significantly impacts students' participation in digital informal learning, with those possessing greater innovativeness showing higher levels of engagement in such activities.

Externally, factors related to Personal Learning Environments and sociocultural contexts play a crucial role. PLEs, often underpinned by social media and collaborative tools, provide essential technical and social support, facilitating the exchange of ideas and peer learning (Deng et al., 2017). Moreover, sociocultural factors, including learners' perceptions of social networks and community norms, influence how digital informal learning is adopted and sustained (Ren, 2012; Yin, 2010). These factors collectively suggest that while intrinsic motivation drives the initial engagement with DIL, external supports and cultural contexts are pivotal in sustaining long-term involvement.

Critical reflections

Despite recent studies advances on DIL and China' education, key gaps remain. First, the possible selves framework has yet to be applied to everyday DIL practices in Chinese higher education. Second, most studies depend on cross-sectional surveys, overlooking students' nuanced experiences of DIL as both enrichment and remediation. Third, there is a lack of mixed-methods research that connects identity-based motivators directly to digital learning behaviours. Many studies have not sufficiently interrogated the potential adverse effects of DIL, such as exacerbating educational inequalities or leading to superficial learning due to information overload. Addressing these gaps is essential for developing digital learning innovations that are both effective and equitable.

Theoretical framework

The possible selves theory, introduced by Markus and Nurius (1986), describes individuals' mental representations of what they might become, what they would like to become, and what they are afraid of becoming. Recent studies have applied this framework in digital learning contexts, such as Frazier et al. (2021) developed the MAPS model, demonstrating how possible selves drive self-regulated behaviours in informal digital learning environments. These findings highlight the utility of possible selves theory for understanding motivation and behaviour in DIL.

According to Harrison (2018), these possible selves are part of a broader narrative aimed at understanding individuals' lives within their specific social contexts. Furthermore, Markus and Nurius (1986) identified two versions of possible selves (see Figure 1): a positive image worth pursuing and a negative image to be avoided. The Ideal Self refers to an individual's aspirational future self that embodies their hopes and goals (Markus and Nurius, 1986). In DIL, the ideal self motivates proactive exploration of digital resources to acquire new skills and knowledge.
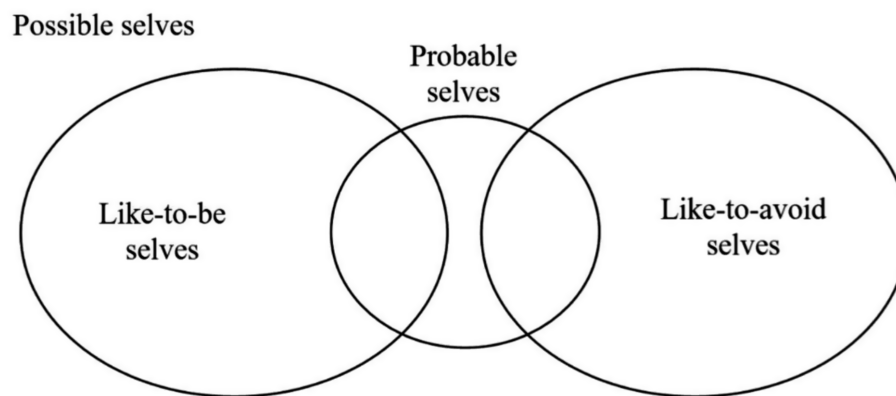
FIGURE 1
Graphical representation of possible selves (Harrison, 2018).

The Feared Self means an individual's representation of what they dread becoming (Oyserman et al., 2007; Oyserman and James, 2011). In DIL, the feared self triggers remedial learning behaviours aimed at avoiding personal failure or skill gaps.

Importantly, the possible selves theory posits that individuals create their own future self-visions, which serve as powerful motivators, especially when they conform to mainstream norms (Harrison, 2018). Notably, these self-images are highly personalised and constructed within the context of an individual's life, determining which future self-image is possible.

The possible selves theory also highlights the individual-oriented nature of these self-images, referring to the personal goal-oriented self. Individuals adjust their strategies, actions, and behaviours within the constraints of their future possible self-image to achieve a positive self or avoid becoming a feared self. Furthermore, an individual's possible self is a dynamic image that responds to specific situations based on personal context (Markus and Nurius, 1986; Markus and Ruvolo, 1989; Oyserman and Markus, 1990), demonstrating how individuals become the architects of their personal development (Lerner, 1978). Possible selves guide individuals in navigating strategies and actions related to their personal development.

According to Frazier et al. (2000) and Jones et al. (2022), one of the most crucial aspects of the possible selves theory is that it links self-concept with personal motivation. From the perspective of higher education, university students can formulate targets and strategies in the process of pursuing and achieving goals according to their envisioned future selves. Jones et al. (2022) claimed that understanding students' personal perspectives is essential because individuals who can clearly express their future self-images are more inclined to implement the necessary tactics to realise their goals. Thus, the possible selves theory provides a platform for researchers to understand the role of digital informal learning in university students' learning experiences. This study utilises this theory to establish the relationship between digital informal learning.

Methodology

This research employs both quantitative (online questionnaires for students) and qualitative (individual semi-structured interviews with students) approaches based on a practical exploratory design, consisting of two phases. Xi'an Eurasia University was selected as the site for this empirical study. In terms of sampling, convenient and random sampling techniques were adopted for participants recruitment. In the first phase, online questionnaires were distributed to explore university students' attitudes and understandings related to digital informal learning. The second phase involved in-person semi-structured interviews to gain a deeper comprehension of university students' personal perspectives, focusing on their digital informal learning motivation, process, and content. The data for this study were collected during a field research visit to the university during the second semester of the 2022 academic year.

In terms of the questionnaire design, the survey comprised 29 closed-ended items covering four dimensions: understanding of DIL (5 items), perceived importance (7 items), usage frequency (5 items), and motivations for use (12 items). Item stems were adapted from established instruments (Song and Bonk, 2016) and refined through two rounds of expert review by three educational researchers. A pilot test ($n = 30$) assessed item clarity, resulting in minor wording adjustments to ensure content validity. For the reliability and construct validity, Cronbach's α for the four subscales ranged from 0.82 to 0.91. The KMO measure (0.88) and Bartlett's test (χ^2 (190) = 1283.45, $p < 0.001$) supported factorability. A principal-axis EFA with oblique rotation yielded a clear four-factor solution explaining 64% of the variance.

In Phase I, we invited 831 undergraduate students at Xi'an Eurasia University to complete an online questionnaire via convenience sampling, yielding 514 valid responses (response rate = 61.8%). All participants volunteered; the sample comprised 218 males (42.4%) and 296 females (57.6%) across eight different majors. The second phase of the study primarily collected qualitative data from semi-structured interviews. Participants were asked to indicate in the first phase survey whether they were willing to participate in follow-up interviews. Eighty students expressed willingness, and ultimately, 18 students were selected for interviews through random sampling. Among the 18 participants, there were nine males and nine females. The interview questions focused mainly on the content and motivations of using digital informal learning, particularly their detailed personal perceptions. The duration of each interview ranged from 60 to 90 min. Researchers conducted six pilot

interviews before the official data collection started. Interviews were conducted face-to-face, with researchers recording the conversations, and the interview data were then coded and categorised.

In terms of qualitative data analysis, the researchers used thematic analysis to establish the significance between participants' perspectives and digital informal learning. This method is a flexible and useful data analysis tool that provides rich, detailed, yet complex data accounts (Braun and Clarke, 2006). The procedure involved reviewing all interview transcripts, conducting basic coding of potential categories, and then developing categories and themes in the data in more depth. All quantitative data were analysed using descriptive statistics to portray students' DIL understanding, attitudes, and behaviours. Given the exploratory focus on capturing the "voice of the student," inferential tests were not conducted. We acknowledge that this approach limits conclusions about subgroup differences; future studies should employ chi-square or t-tests to examine demographic and disciplinary contrasts.

Findings

The understanding of DIL

A total of 514 students' questionnaire survey responses were analysed. Regarding participants' understanding of DIL, students' responses were distributed in a diamond shape (see Table 1). In general, students are not very familiar with the concept of DIL. Specifically, over 40% of students have a neutral grasp of DIL, while 18.68% understand it and 25.1% do not understand it well. The group that completely understands DIL constitutes only 6.61%, whereas 8.56% of respondents reported that they fully do not understand it.

Furthermore, in response to the importance of DIL to personal learning, the majority of participants reported a positive signal and more than 80% of them viewed DIL as important to their learning (see Table 2). Only around 10% of participants showed an opposite attitude compared with the mainstream trend.

Additionally, with the result of students' time consumption on DIL, while 35% of participants reported they have relatively little daily use (Less than 1 h) of DIL each day, around 65% of participants utilise DIL for over 1 h per day (See Table 3). In particular, there are more than 20% of participants' daily use of DIL over 2 h.

As can be seen from the data above, although students are not familiar with the concept of DIL in general, the fact is that DIL has become an integral part of their personal learning experience.

TABLE 1 The extent of students' understanding of DIL.

Understanding extent	Student number	Percentages
Completely do not understand	44	8.56%
Not understand well	96	18.68%
Neutral	211	41.05%
Understand	129	25.1%
Completely understand	34	6.61%

Especially, over 80% of participants recognised the significance of DIL for their personal learning, and around 65% of participants now include DIL in their daily learning routine.

Supplementary function and inadequate teaching quality

The researchers discovered that the supplementary function of DIL and the weak teaching quality in formal education were crucial factors influencing university students' use of DIL, based on the interview data obtained. This section will demonstrate how students view the influence of these two crucial aspects on their utilisation of DIL.

Supplementary function

University formal curricula are often restricted in resources, making it challenging for university students to fulfill all their learning requirements solely through formal learning (Dabbagh and Kitsantas, 2012). Peeters et al. (2014), and Gramatakos and Lavau (2019) claimed that informal learning is vital in contributing to formal learning by filling gaps in formal curricula. The supplementary function to formal learning is an important reason for using DIL among university students. One interviewee noted that formal learning cannot provide enough information for acquiring a comprehensive understanding of curriculum content:

> It is difficult to fully grasp key knowledge points only through classroom learning. I often search for related information on the Internet to learn more, which helps me better understand the learning content (No.9 Interviewee).

Another interviewee thought it is challenging to maintain concentration in class for extended periods and perhaps miss out on

TABLE 2 The importance of DIL to students.

Importance level	Student number	Percentages
Strongly not important	7	1.36%
Not important	47	9.14%
Neutral	43	8.37%
Important	351	68.29%
Strongly important	66	12.84%

TABLE 3 Students' average time consumption on DIL per day.

Time consumption	Student number	Percentages
Less than 60 min	181	35.21%
1–2 h	229	44.55%
2–4 h	79	15.37%
More than 4 h	25	4.86%

important information but believed that DIL can effectively address this issue:

> Because my concentration is not very good, it is easy to miss knowledge in class. I think online resources can not only help me consolidate what I have learned but also help me re-learn what I have missed (No.8 Interviewee).

Both No.3 and No.9 interviewees highlighted that DIL can offer additional knowledge beyond traditional classroom instruction to enhance their learning outcomes:

> Frequently, due to the class time constraints, the content of the teacher's lecture is limited, but some online classes can provide me with additional information to supplement, which is especially useful for learning key knowledge points. (No.3 Interviewee).

> Compared with formal teaching in the classroom, the teaching videos on some learning websites can help me learn more expanded content. I often search for different learning resources about the same knowledge point to enhance my understanding (No.9 Interviewee).

Notably, university students acknowledged the supplementary and supportive function of DIL in formal education, highlighting its crucial effect on ensuring students' personal learning coherence. Specifically, DIL enhances formal learning by filling gaps in understanding, reinforcing and enriching the concepts learned in the classroom, and offering diverse viewpoints on the same subject. This means that the role of DIL not only complements formal learning but also goes beyond this standard by further developing students' knowledge and abilities. Due to this characteristic, DIL may play a part in constructing students' possible ideal selves, representing a version of themselves that seeks more knowledge in their curriculum. Although students may have an unclear picture of their future academic development, they understand that a better comprehension of their existing curriculum knowledge could position them closer to the person they aspire to be.

Additionally, participants reported that the supplementary function of DIL is particularly effective for their major course learning, especially regarding homework and exams, which can influence their Grade-Point Average (GPA). One interviewee emphasised that DIL is the core approach for his major course learning:

> My major course is digital media. There is a lot of content I need to learn, but the teacher can only offer very limited information compared to the required learning content in this course, and the textbooks are out of date. I bought many extra courses online to learn so that I can scrape through this course. I'm sure I'll fail if I don't do extra study by myself. I believe 90% of the study of this course is self-study relying on online courses. (No.10 Interviewee).

Furthermore, interviewees No.12 and No.14 highlighted that DIL is becoming increasingly necessary for achieving course homework completion:

> I have to use DIL to finish my homework. If I want to get a high score on my homework, I must effectively get help. DIL helps me a lot. (No.12 Interviewee).

> Usually, it is impossible to complete my major course homework only through the class, so I use DIL with homework orientation in general (No.14 Interviewee).

Additionally, interviewees No.11 and No.18 noted that DIL can provide detailed instructions for their major practical courses:

> My major course requires me to master the skill of producing videos, if only listen to the teacher, it is not enough. The video-making tutorials on the Web are very detailed, and I can pass this course by relying on various online tutorials (No.11 Interviewee).

> I usually learn my major practical skills from the learning website, such as my design and drawing skills, much detailed knowledge of which are inaccessible in my major classes, which is very helpful for passing the exam (No.18 Interviewee).

The significance of major courses in university students' academic development is evident. Participants highlighted a strong correlation between the use of DIL and their major course learning. Furthermore, students placed DIL in an important position in the learning scenarios of their major courses, especially for passing specific course exams. Due to the potentially serious consequences of failure in major courses, students urgently need a way to cope with this problem, and DIL has proven to be quite beneficial in this context. In other words, the potential risk in students' major course learning is likely to generate a fearful self when considering the consequences of unsuccessful performance. Under these circumstances, DIL provides opportunities for students to capture additional useful information, enhancing the possibility of passing the major course and supporting them in avoiding the emergence of their unsuccessful selves.

Inadequate teaching quality

Participants reported dissatisfaction with the existing substandard quality of teaching, particularly with the inappropriate teaching modes and instructional approaches used by teachers. The current teaching quality is inadequate to address university students' learning demands, serving as a significant trigger for them to utilise DIL for learning. Initially, participants demonstrated displeasure with the theoretical knowledge-oriented teaching mode. Interviewees No.12 and No.15 pointed out that the current theoretical knowledge-focused teaching lacks adequate instruction to enhance their understanding:

> Now the classroom learning effect is not good. The teacher taught too much theoretical content. I find it very difficult to understand, and I can only find additional information to help me. My classmates around me are also in the same situation as me. I think the university should improve classroom teaching to help us understand course content. Now I can only go online to find course videos and resources to learn by myself (No.12 Interviewee).

> What the teacher taught is not understandable at all; it is all theoretical knowledge. I certainly cannot learn anything if not through the online resources in my courses (No.15 Interviewee).

It is worth noting that the current teaching mode may not effectively address the challenge of delivering knowledge from teachers to students, leading to unexpected learning difficulties. The version of possible selves that students construct in this situation is likely to be the self who might fail the course, which they want to avoid. Hence, DIL may serve as a key strategy for students to deal with this issue, as it can offer rich and dependable academic resources and materials, enabling students to address learning deficiencies present in formal learning.

Furthermore, participants mentioned several pedagogical issues in the current formal teaching. These issues pose serious challenges for students in their academic development, forcing them to rely on DIL. Interviewee No.17 expressed a negative attitude towards the current teaching skills of their teachers:

> *Classroom learning for me is just a closed environment where the teacher repeats the PowerPoint to you. It's no different than me looking at it by myself. It's really boring and useless. Courses on websites are more interesting and helpful (No.17 Interviewee).*

Interviewee No.11 highlighted that the didactic teaching pedagogy employed by teachers significantly diminishes students' learning experience:

> *In class, the teacher just forced the knowledge into us. They taught so fast that we didn't have enough time to understand the knowledge. I personally do not like this way. The classroom is not attractive to me right now. I can only learn course content via online course videos. I think online courses are more attractive to me now (No.11 Interviewee).*

Interviewee No.10 mentioned obvious shortcomings in the current teaching and attributed these issues to a lack of training in pedagogical skills for university teachers:

> *I think the current classroom teaching is very inefficient. The teacher's lectures are quite chaotic, and there is no clear teaching goal. Teachers need to improve their teaching skills. I'm not happy now. I can only learn knowledge through online courses (No.10 Interviewee).*

The single and inadequate teaching skills of university teachers hinder the effectiveness of students' learning. Teachers' inability to provide adequate guidance is likely to result in students' lowered expectations of their learning outcomes, which may generate an imagination of possible failed selves in individual academic performance. Additionally, the absence of effective support at various levels results in students independently seeking alternative learning pathways to address the existing contradictions. DIL offers an effective and feasible solution for students to improve their responsiveness to courses, thereby alleviating the burden of defective teaching.

The DIL inherent benefits

Because digital informal learning (DIL) is a learning approach based on internet platforms, it shares the fundamental characteristics of online learning. For instance, online learning offers a wealth of quality and pertinent learning materials, and DIL grants students the advantages of flexible and dependable learning (Ang et al., 2018; Jin et al., 2019). These benefits provide essential conditions for students to achieve comprehensive continuity in their learning dynamics.

Rich and free information

Participants are generally satisfied with the abundance of online learning resources, which significantly alleviates their shortcomings in formal learning. Importantly, most online learning courses are free, which does not impose any financial pressure on students. Thus, students' learning engagement might be positively stimulated by adopting DIL. One interviewee highlighted that the richness of information is the key reason why DIL has become his preferred learning strategy:

> *Now I mainly use DIL to learn, because there are a lot of reliable resources which can help me get a deeper and more comprehensive understanding of my courses. And generally, the most-watched courses are really helpful (No.1 Interviewee).*

Additionally, the absence of additional charges for utilising DIL is a primary factor that motivates students to opt for its use. Another interviewee specifically mentioned this feature of DIL:

> *It's really expensive to pay for extra face-to-face classes and tutorials; I can't afford it. But online resources are mostly free, which is really friendly for students (No.13 Interviewee).*

Abundant learning resources offer students ample learning opportunities and topics, particularly addressing their requirements for breadth and depth of knowledge. By contrast, due to limitations of time and teaching materials, formal university teaching has obvious shortcomings in meeting students' learning needs. As students develop their academic achievements, they realise that formal university education can only provide a restricted foundation. In other words, students need a place where they can access adequate and reliable learning information to meet their learning needs, and the internet works well for them. Moreover, although numerous face-to-face classes and tutorials are available in the market, this path incurs extra costs for students. The cost rises proportionally with the duration of learning, making it understandable why students generally opt for DIL. It is worth noting that in discussions on this topic, participants commonly expressed the view that these abundant resources were essential for acquiring a more comprehensive grasp of course knowledge. This tendency indicates that students construct a vision of pursuing better learning achievements rather than avoiding negative scenarios. In other words, the version of the possible self generated by students under this theme is more likely to be located in the quadrant of the desired self.

The flexibility

All participants confirmed that the flexibility of DIL is a crucial reason for its use. This flexibility greatly enhances the learning

experience for students, particularly by allowing them to decide on the learning place, time, and content. This autonomy enables students to have greater control over their personal learning. One interviewee expressed his appreciation for the ability to learn anywhere:

> I can choose any place where I like to study, such as the dormitory, canteen, or library, which feels quite great (No.2 Interviewee).

Other interviewees highlighted the time flexibility offered by DIL, which perfectly matches their personal learning habits and enhances their learning effectiveness:

> The learning time can be matched freely. I usually choose the time when I can focus to study to start, and I'm satisfied with the effect (No.6 Interviewee).

> This learning way there is no time limit, I can completely decide what time to learn. I like the freedom of not having to learn at fixed time. This freedom always making me have more interests to learn (No.7 Interviewee).

In particular, one interviewee confirmed that having control over the specific time during the learning period has greatly improved her learning experience:

> It's very important for me to control the pace of my study. In online learning, I can not only pause and play the class at any time but also play at double speed or only watch important clips. This feeling of control makes learning more comfortable for me (No.3 Interviewee).

Furthermore, other interviewees reported that DIL provides them the flexibility to choose what they want to learn, which is significant in matching their personal learning needs:

> I think it is very important to have the freedom to choose the learning content, and I generally choose the content according to my weak aspects to learn (No.5 Interviewee).

> The same knowledge points can be taught differently by each teacher, especially in the presentation of the content. I have many options of teachers from online courses. I like the detailed and clear content, and I can find it easily. This type of learning video helps me a lot in my academic development (No.11 Interviewee).

The flexibility that DIL provides equips students with autonomy in their learning. In terms of the version of the possible self, this flexibility does not guide students into a particular version of the possible self. However, the crucial point is that wherever the coordinates of the student's possible self, this autonomy in learning serves as the foundation for individual action. This flexibility makes a considerable contribution to the student's academic development. It is especially reflected in the alignment of personal learning habits with the needs of specific learning content, which can significantly improve their learning experience and effectiveness.

The personal agency and hobby orientation

In this study, personal agency is considered a relatively long-term concept rather than including short-term versions, to avoid confusing personal short-term agency with specific phased academic pressures. Furthermore, a significant amount of material demonstrates a strong correlation between hobbies and DIL in the participants' reports, which deserves careful consideration.

The personal agency

Schoon and Heckhausen (2019) contend that personal agency involves deliberate action and the monitoring of one's actions, highlighting the influence of individual self-guidance and the challenges faced. According to Eraut (2004), personal agency plays a crucial role in initiating and sustaining informal learning, and individuals with high levels of personal agency are more likely to actively seek out additional learning opportunities. Interviewees No.10 and No.16 confirmed that their future development plans significantly impacted their use of DIL:

> I have job anxiety because the employment competition in my major is very fierce. Time is very tight for me, and I need to improve my employment competitiveness in these years, so I carry out a lot of independent extra learning. So I think all my learning is driven by my personal employment plan (No.10 Interviewee).

> I believe everyone has a plan for their future. I know my goal very well; I want to pursue a master's degree. To achieve my goal, I need to work hard and learn as much as possible. Therefore, this extra learning is essential (No.16 Interviewee).

Additionally, interviewees No.1 and No.2 mentioned that DIL is key for them to acquire a better position in the academic race:

> The content taught in class is the same, and everyone is learning the same thing. If you want to rank high, you need to put in extra effort to learn more. I think this kind of flexible online learning is quite reliable and suitable (No.1 Interviewee).

> Personal academic ranking is really important to me; I don't want to lose to anyone else. So I definitely have to find other ways to do extra learning, especially for subjects I'm not good at. I have been learning from online courses since my university life started (No.2 Interviewee).

Participants demonstrated that their personal agency is dominated by two different dimensions: their future plans and academic competition. Notably, the possible selves they generated are distributed across both versions. The self who wants to achieve a higher degree or academic ranking represents the desired self. In contrast, the self who fears employment failure or does not want to lose to peers in academic performance represents the self they want to avoid. In other words, DIL functions as an effective tool in the pursuit of both possible self versions in terms of students' personal agency.

Hobby orientation

Hobbies generally originate from individual interests and enthusiasms. According to Edelson and Joseph (2004), when individuals engage in hobbies, their motivation stems from intrinsic interest rather than extrinsic benefits. This intrinsic motivation fuels active participation and exploration, leading individuals to continuous learning. Participants generally felt that they could not engage in formal interest classes and training due to academic and financial pressures. Under these circumstances, DIL provides a feasible and practical way for students to connect with their hobbies. One interviewee reported that DIL significantly increased his hobby engagement:

> *I think it's very cool to play an instrument. I am learning the guitar through online teaching videos, which is not only useful but also much more interesting than blindly teaching myself. This approach makes me more willing to keep learning it (No.4 Interviewee).*

Another interviewee mentioned that DIL offered the opportunity to pursue her hobby, enriching her extracurricular life and relieving academic pressure:

> *I follow some drawing bloggers on social media and then follow their videos to learn how to draw well. Especially since there is only study in my daily life, which is too boring. It relaxes me a lot to learn drawing via online videos (No.17 Interviewee).*

It is evident that DIL plays a core role in contributing to students' personal hobby development. Particularly when students face limited time and financial resources, this strategy offers a highly cost-efficient and flexible platform for pursuing hobby learning. Furthermore, participants did not depict learning hobbies as a means to avoid a fearful self. Conversely, the opportunity for students to deepen their understanding and proficiency in their chosen hobbies through DIL is a tangible expression of desired personal growth. In other words, this situation is a concrete manifestation of pursuing the possible self that the student wants to become.

Discussion

This study aimed to explore how Chinese university students critically perceive and navigate the opportunities and challenges of DIL, guided by the theoretical framework of Possible Selves. Specifically, the research sought to uncover the motivational role of students' envisioned identities, encompassing both ideal selves they strive to become and feared selves they aim to avoid, in shaping their engagement with digital informal learning practices. Quantitative findings revealed that although a majority of students demonstrated limited conceptual familiarity with DIL, more than 80% nonetheless recognised its importance to their personal learning, with approximately 65% regularly integrating DIL into their daily learning routines. Complementing this, qualitative insights from semi-structured interviews illustrated how students consciously adopted DIL strategies to address perceived gaps in formal education, overcome constraints such as limited teaching quality and outdated curricular resources, and pursue broader developmental goals in their academic and personal trajectories.

The findings from this study directly address our research objective, which was to explore how Chinese university students critically perceive and navigate the opportunities and challenges of digital informal learning (DIL). One significant insight emerging from our data is the stark contrast between students' limited theoretical understanding of DIL and their active, routine utilisation of digital resources for informal learning purposes. Despite only a small minority (6.61%) fully grasping the formal definition or theoretical nuances of DIL, a substantial majority, over 80%, nonetheless acknowledged its importance to their learning processes. Furthermore, approximately 65% regularly engaged with digital learning platforms for periods exceeding 1 h daily. This evident gap between conceptual knowledge and practical use clearly illustrates that students are intuitively integrating digital learning practices into their academic routines without systematic instructional support or explicit theoretical grounding. This paradox between students' practical digital engagement and limited conceptual clarity extends existing scholarship, highlighting intuitive rather than reflective digital learning practices.

Such a situation highlights a critical issue identified within our research objectives, which is understanding how students practically adopt digital informal learning behaviours amidst noticeable gaps in their explicit conceptualisation or formal educational guidance. This finding points towards potential vulnerabilities, such as information overload or superficial learning, which educational initiatives should proactively address. In particular, while recent studies underscore the empowering nature of DIL for enhancing student autonomy (Goodyear, 2021; Heidari et al., 2021; Liu and Ma, 2024; Rezai, 2023), our findings critically highlight the simultaneous risks of over-dependence and superficial engagement. This finding carries significant implications, particularly emphasising that higher education institutions must urgently develop structured interventions aimed at bridging students' intuitive digital learning behaviours with their conceptual understanding of these practices. Specifically, this entails embedding comprehensive digital literacy programmes within curricula, which not only impart technical skills but also promote reflective and critical engagement with digital content, thus ensuring students move from intuitive usage towards more thoughtful and informed practices.

Moreover, the significance of these findings extends notably to students' perceptions and usage of DIL as an indispensable supplementary resource, driven largely by existing constraints within formal educational structures. Among these constraints, students prominently highlighted issues such as insufficient classroom instructional time, reliance on outdated or irrelevant learning materials, and adherence to traditional, didactic teaching methodologies (Noor et al., 2022). The inherent flexibility and self-directed nature of DIL noted by students in this study corroborates earlier scholarly assertions regarding the value of informal digital environments in fostering personalised, lifelong, and interdisciplinary learning experiences (Deng et al., 2017; Peters and Romero, 2019; Song and Bonk, 2016). Students consistently reported that formal education alone was inadequate for fully addressing their learning needs, particularly emphasising subjects that demanded practical skills, updated knowledge, or specialised expertise. This aligns closely with previous research arguing that informal learning critically supplements and fills gaps left by formal curricular limitations (Gramatakos and Lavau, 2019; Peeters et al., 2014; Selwyn, 2007).

Furthermore, recent literature has increasingly highlighted that an over-reliance on traditional, teacher-centered instructional methods often propels students toward digital alternatives, potentially exacerbating issues related to fragmented knowledge acquisition and information overload (Aulakh et al., 2025; Humphries and Clark, 2021).

Consequently, the findings emphasise that students do not view DIL merely as an optional enrichment tool but rather as a critical, necessary strategy to overcome the identified shortcomings within their formal educational experiences. This reliance points to an urgent need for educators, curriculum designers, and policymakers to critically re-evaluate and enhance traditional pedagogical approaches and curricular structures (Alenezi, 2023), aiming to more effectively align formal educational provision with the rapidly evolving digital and informal learning practices students naturally gravitate towards. For instance, institutions could adopt a hybrid curricular approach, combining traditional instruction with structured digital informal learning components such as online modules, interactive digital assignments, and multimedia resources explicitly linked to learning objectives. Embedding these elements directly into the curriculum would not only foster coherence between formal and informal learning but also mitigate potential drawbacks associated with fragmented or superficial knowledge acquisition. A strategically integrated hybrid model would also enhance students' ability to make explicit connections between theoretical concepts taught in the classroom and practical applications accessible through digital platforms, thus promoting deeper cognitive engagement and retention of knowledge.

In addition, professional development for educators in digital pedagogy emerges as another critical area requiring institutional attention (Ajani, 2024; Goos et al., 2020). The findings underscore that without adequate support and training, educators may struggle to effectively guide students in navigating the increasingly complex digital learning landscape. Providing structured professional development programmes could significantly enhance educators' digital pedagogical competencies, equipping them with essential skills to evaluate, select, and integrate high-quality digital resources within their instructional strategies. Effective professional training programmes should encompass modules on assessing digital resource quality, aligning digital content with curricular goals, and fostering active, reflective, and critical engagement among students (Aulakh et al., 2025). These professional development initiatives could thus empower educators to act as knowledgeable facilitators rather than mere transmitters of information, ultimately promoting a culture of critical inquiry and autonomous learning among students. Furthermore, well-trained educators would be better positioned to identify and mitigate potential pitfalls associated with digital learning, such as superficial engagement or information overload, thereby ensuring students' digital learning experiences are both meaningful and coherent.

Interpreting these findings through the lens of Possible Selves theory offers deeper insights into student motivation. The construct of the ideal self effectively captures students' aspirations to achieve higher academic performance and professional success through proactive engagement with digital informal learning. Participants clearly demonstrated strategic use of digital resources to enhance knowledge and skills that formal education alone could not adequately provide, reflecting broader research on digital learning behaviours driven by positive self-projections and intrinsic motivational factors (Frazier et al., 2021; Littlejohn et al., 2016; Jin et al., 2023). Specifically,

students actively sought digital content to supplement their academic coursework, acquire additional competencies, and prepare for competitive job markets, revealing a clear link between their envisioned ideal self and tangible learning behaviours.

Conversely, the feared self emerged as an equally influential motivational force (Stevenson, 2012). Students frequently expressed concerns related to academic failure, inadequate skill development, and uncertainties regarding future employability. These apprehensions consistently prompted remedial and compensatory use of digital learning platforms, aimed at mitigating perceived gaps or deficiencies within their formal education. This behaviour supports existing research that identifies fear-based motivations as powerful catalysts for preventive learning actions (Oyserman and James, 2011; Henderson et al., 2017; Wang et al., 2024). For instance, students engaged extensively with digital tutorials, supplementary videos, and additional online courses, driven primarily by their anxiety to avoid failure and secure a more stable professional future.

Thus, the findings substantiate and significantly extend the application of Possible Selves theory to digital learning environments. This theoretical framework proves valuable in capturing the complex interplay between positive (ideal self) and negative (feared self) identity constructs, offering nuanced insights into their distinct yet complementary roles in shaping students' learning behaviours. Consequently, educators and policymakers could leverage this dual motivational understanding to design targeted interventions and digital literacy programmes, effectively addressing students' varied academic needs and aspirations.

Conclusion

Applying a mixed-methods design grounded in possible selves theory, we show that Chinese undergraduates embrace DIL both to enrich formal coursework and to remediate instructional shortcomings. Despite heavy daily engagement, many students hold a partial, fragmented grasp of DIL's principles, a gap that both fuels stronger self-directed learning and risks superficial or disjointed knowledge. These dynamics underscore DIL's promise for personalised, flexible support alongside its need for structured integration to maximise educational value.

Theoretically, we extend Markus and Nurius's (1986) possible selves theory into digital contexts by identifying two distinct motivational pathways: ideal selves drive exploratory DIL behaviors while feared selves trigger targeted, remedial engagement.

In addition, by mapping how identity-based motivators interact with cognitive and contextual factors, we offer a comprehensive dual-pathway model that enriches understanding of self-regulated learning in online environments.

We recommend the following integrated approach to leverage DIL effectively:

First, universities should embed curated DIL resources directly into their curricula. For each course module, instructors can select high-quality short video demonstrations, interactive case studies, and structured reflection prompts that align with the module's learning objectives. By integrating these materials into the Learning Management System (LMS) alongside lecture slides and readings, students encounter DIL opportunities as a seamless extension of formal instruction rather than as an add-on.

Second, institutions need to ensure platform interoperability. IT departments and instructional designers should work with Massive Open Online Course (MOOC) providers to establish Representational State Transfer that allow faculty to import vetted open-course content, such as videos, quizzes, and forum discussions that straight into the university's LMS. This seamless import mechanism reduces technical barriers for instructors, encourages consistency in resource quality, and gives students a unified learning environment.

Finally, effective use of DIL hinges on ongoing faculty development in digital pedagogy. We suggest rolling out biannual workshops that cover core topics: evaluating the credibility of online resources, curating content suited to specific learning outcomes, and using analytics dashboards to monitor and support student engagement. To reinforce these skills, each workshop cohort should be paired with a peer-mentoring group, ensuring that instructors share best practices and continue refining their approach throughout the academic year.

At the policy level, institutions and governments should implement robust quality-assurance frameworks, drawing on Open Educational Resources (OER) peer-review standards, to vet and accredit DIL materials for accuracy, pedagogical alignment, and accessibility. To ensure equitable access, campuses must invest in high-speed Wi-Fi, device-loan programs, and subsidised subscriptions to digital libraries. Additionally, creating centralised, discipline-specific repositories with detailed metadata (skill level, learning objectives, format, language) will streamline discovery and reuse of vetted resources across institutions, fostering collaboration and continuous improvement in DIL provision.

Despite offering valuable insights, this study's single-institution sample and exclusive reliance on self-reported data limit its external validity and introduce potential response biases. In addition, the cross-sectional design precludes any assessment of how DIL engagement and possible selves evolve over time. To strengthen generalisability and deepen understanding, future research should sample multiple universities across diverse provinces and disciplines, employ longitudinal methods to track students' DIL behaviors and identity development, integrate objective analytics (e.g., LMS clickstream, time-on-task metrics) to validate self-report findings, and implement quasi-experimental or randomised studies to test the impact of our proposed curricular embedding and faculty training interventions.

Data availability statement

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

Ethics statement

The studies involving humans were approved by Institutional review board, Xi'an Eurasia University. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

ZL: Writing – original draft, Formal analysis, Project administration, Supervision, Methodology, Writing – review & editing, Investigation, Conceptualization. JZ: Investigation, Writing – review & editing, Writing – original draft. CL: Methodology, Investigation, Writing – original draft. QH: Investigation, Methodology, Writing – original draft.

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