

Design Thinking as a Case-based Learning for College General Education Courses

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Abstract

Design thinking is vital for attaining sustainable development goals (SDG) or SDG in education. This article investigates the status of design thinking education in realizing SDG in education. The intentional requirement for using innovative design to enhance national competitiveness is discussed regarding the "Made in China 2025" policy document. It then investigates the current status of design thinking curriculum development in China, counting the adoption of Western models and the formation of project cooperation mechanisms, the combination of design thinking into general education courses, and the rise of online courses over the development of the Internet. Five international best practices of design thinking courses are offered, i.e., Stanford University, the University of Miami, the Royal College of Art, Vanderbilt University, and Tama Art University. These practices tell the different features of design thinking courses and emphasize the importance of interdisciplinary collaboration, actual problem-solving, and the cultivation of a humanistic spirit and social responsibility. The article then highlights vital lessons and conclusions from design thinking education in general higher education courses. These include the importance of human-centered, social, and computational thinking, the value of interdisciplinary collaboration in developing collaborative empathy, and the practical problem-solving skills and creativity that design thinking can undertake. To sum up, the design thinking course is an effective way to improve the design thinking level of college students and change the existing teaching methods of various majors, and it has significant benefits for both students and enterprises. Overall, the paper provides a comprehensive picture of the importance of design thinking education in achieving educational sustainability, highlighting its potential for developing innovative and practical problem-solving skills in college students and its relevance to various disciplines and industries.

Keywords: Case-based Learning · College General Education Courses · Design Thinking · Problem-solving

Introduction

A. Background on sustainable development goals in education

In November 2015, the United Nations Educational, Scientific and Cultural Organization (UNESCO) passed the "2030 Education Framework for Action" in Paris (The Global Education Community Adopts and Releases the Education 2030 Action Framework, n.d.)

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with the support of 186 member countries. Under this framework, Sustainable Development Goal 4 (SDG4) aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. SDG4 seeks to achieve sustainable development in education by focusing on academic literacy and how to assess it, nurturing students' practical skills and lifelong learning abilities, and emphasizing the accessibility of education through technology in informal and non-formal contexts. Many countries have established sustainable development committees at the national level to implement the 17 sustainable development goals and incorporate some of them into national education development plans.

B. Importance of design thinking education for sustainable development

In May 2015, the State Council of China issued the strategic document "Made in China 2025" to comprehensively promote the implementation of the strategy to develop a powerful industrial nation. This is China's first 10-year action plan to carry out the strategy to develop a powerful manufacturing nation (Notice of The State Council on the Issuance of Made in China 2025, 20150519). The document emphasizes the need to promote the transformation of "Made in China" to "Created in China," the transformation of "China's speed" to "China's quality," and the transformation from a large manufacturing country to a strong manufacturing country. At a time when products are transitioning to brands, consumption is upgrading, and mobile internet is booming, an innovation-driven economy that enhances national competitiveness through innovative design is also becoming a constant effort of various countries (Bason, n.d.). Design competitions conducted by countries such as the United Kingdom, Finland, and South Korea have already shown that a country's comprehensive competitiveness is closely related to its level of design development. Using innovative design to achieve sustainable development and industrial transformation, upgrading China's economy and society, and promoting the improvement of national competitiveness are strategic requirements for China's further development. In the global network era, innovative design, as a creative integrated innovation and creative activity, is a crucial link for transforming technological achievements into real productivity.

C. Objective of the paper

The objective of this paper is to investigate the significance of design thinking education in fostering sustainable development in higher education, with a particular focus on its implementation in a computer-aided Design course in China. By analyzing the current state of design thinking curriculum development in China and examining international best practices from renowned institutions, the paper seeks to identify key lessons and implications for incorporating design thinking into the university general education curriculum. Furthermore, the paper aims to demonstrate the potential benefits of design thinking courses for cultivating innovative and practical problem-solving skills among college students and explore their relevance for various disciplines and industries.

Strategic Requirement for Innovative Design in China

A. "Made in China 2025" policy document

In May 2015, the State Council of China issued a strategic document called "Made in China 2025" to implement the plan for creating a strong industrial nation. This is the action plan for the first decade of China's implementation of the strategy of building a solid manufacturing country (Notice of The State Council on the Issuance of Made in China 2025, 20150519).

The basic principles are as follows:

1. **Innovation-driven.** Adhering to the core position of innovation in the overall development of the manufacturing industry, improving the system environment conducive to innovation, promoting cross-disciplinary and cross-industry collaborative innovation, breaking through crucial standard technologies in many crucial areas, promoting digitization, networking, and intelligence of the manufacturing industry, and taking the path of innovation-driven development (Zhou, 2013).
2. **Emphasize quality.** Maintaining quality is the cornerstone of creating a strong manufacturing nation, expanding companies' primary responsibility for quality, and fostering independent brand development and quality technology research. Developing a market environment for ethical operation, establishing a system of rules, regulations, and standards, quality supervision, and advanced quality culture, and following the route of winning by quality.
3. **Green development.** Adhering to sustainable development is essential to building a strong manufacturing country, strengthening the promotion and application of energy-saving, environmental protection technology, process, and equipment, and fully implementing clean production. It was developing a circular economy, improving resource recycling efficiency, constructing a green manufacturing system, and taking the path of ecological civilization.
4. **Structural improvement.** Adhering to structural adjustment is a crucial component of creating a strong manufacturing nation, actively advancing advanced manufacturing, modernizing and upgrading traditional industries, and encouraging the shift from production- to service-oriented manufacturing. Industrial spatial layout optimization, development of several industry clusters and company groupings with core competitiveness, and pursuit of quality and efficiency improvements.
5. **Talent-oriented.** Recognizing talent as the cornerstone of creating a strong manufacturing nation, establishing a sound and scientific mechanism for selecting, hiring, and nurturing talent, and accelerating the training of professional and technical personnel, management personnel, and skilled personnel that are urgently required for the development of the manufacturing industry. Fostering a widespread innovation and entrepreneurship culture, assembling a skilled and organized manufacturing workforce, and following a talent-led development strategy.

B. Enhancing national competitiveness through design thinking

Design thinking is a problem-solving approach emphasizing human needs and experiences to create innovative solutions (Tim, n.d.). It is a methodology that can be applied to various industries and disciplines. Design thinking has been used in expected areas such as art, engineering, business, climate change, medicine, library services, and sustainability (Dym et al., 2005) (Dunne & Martin, 2006). Using design thinking, countries can enhance their national competitiveness in several ways.

Firstly, design thinking may assist nations in creating novel goods and services that satisfy domestic and international markets. Design thinking encourages collaboration among different stakeholders, including designers, engineers, entrepreneurs, and consumers. By working together, they can identify opportunities for innovation and create products and services that are user-friendly, sustainable, and competitive. As an example, Singapore's Health Promotion Board (HPB) employed design thinking when creating the "Healthy 365" smartphone application (Healthy 365 by the Health Promotion Board (HPB) Singapore, 2023). The software offers individualized health advice and tracking tools to persuade Singaporeans to embrace better lifestyles. HPB collaborated with a nearby design company, STUCK Design, to conduct research and create the user interface for the app. Over a million people have downloaded the app, earning numerous design accolades.

Secondly, design thinking can aid nations in enhancing their public services and infrastructure. Countries can develop more effective and efficient services that better suit their residents' needs by applying design thinking ideas to public services like healthcare, education, transportation, and social welfare. Governments can use design thinking to develop more inclusive and fair policies that support societal well-being and economic growth. For instance, The Public Libraries in Aarhus (Denmark) and Chicago (USA), with funding from the Gates Foundation, created the Design Thinking for Libraries toolkit to introduce a way of working that will help students to understand their needs and engage the communities (Design Thinking for Libraries, n.d.). The difficulties facing librarians are substantial, intricate, and numerous. They need fresh viewpoints, new tools, and new strategies as a result. Design thinking allows students to work together to discover what local communities want and experiment to create services, programs, and processes to meet their changing needs (Dunne & Martin, 2006).

Thirdly, design thinking may assist nations in growing their creative industries, such as fashion, entertainment, and advertising. These sectors are becoming more and more significant contributors to economic expansion and job creation. Countries can attract brilliant designers, artists, and entrepreneurs who can develop new goods, services, and experiences that improve national competitiveness by creating a culture of creativity and innovation. South Korea's government has been utilizing design thinking to promote its expanding creative sectors, such as fashion, design, and entertainment. The "Creative Economy" project, which the government started in 2013, intends to encourage innovation and entrepreneurship by giving money and resources to creative firms. Several prosperous businesses have been founded due to the campaign, notably Kakao, a messaging app with more than 40 million users globally.

Finally, design thinking has the potential to improve national competitiveness significantly. By applying design thinking principles to a wide range of industries and disciplines, countries can create innovative products and services, improve their infrastructure and public services, and develop their creative industries. By embracing design thinking, countries can become more competitive, innovative, and prosperous.

Status of Design Thinking Curriculum Development in China

Design thinking is a humanistic methodology with innovation as its goal (Bason, n.d.). More importantly, the core worth of design thinking lies in resolving complex or wicked problems rather than solving problems with pre-existing answers. The complexity of these wicked problems is difficult to analyze and explain through rational scientific paths, and designers need to reconstruct and interpret them in the interaction process. As an effective methodology, design thinking has been widely applied in various disciplines to promote innovation, such as architecture and engineering, information technology, business and management, and education. At the same time, its application in sustainable development and social innovation is also increasing. Based on widespread design thinking teaching practices, the three primary methods in which design thinking is now applied in higher education will be addressed here.

A. Learning from Western models, establishing project collaboration mechanisms.

The introduction of design thinking to China began with collaboration and learning from overseas universities, from art schools to comprehensive universities.

Firstly, cultivating design thinking has become a major goal for talent development in design/art schools.

China Media University borrowed relevant majors and experiences from the University of Potsdam in Germany and offered a series of courses for postgraduates. In October 2014,

the Design Thinking Innovation Center was established in the Art Department of China Media University (Gu & Wang, 2015).

China Academy of Art began offering courses related to design thinking in 2012, making it one of the earlier schools to offer such courses. In 2017, it held its fifth joint summer teaching program with the Hong Kong University of Science and Technology, offering a course on "Design Thinking" with a focus on "smart health"(Shen, n.d.). The course emphasized interdisciplinary and systematic approaches, with the China Academy of Art focusing on artistic design and the Hong Kong University of Science and Technology emphasizing the realization of technology and products complementing each other. The course covered multiple fields, such as design, engineering, business, and art, with projects driving the curriculum to enable students to apply theory to practice while completing hands-on projects. The course aimed to cultivate innovative design talent by cultivating interdisciplinary creativity and integrating art and technology. On August 12 of the same year, the "Design Thinking" summer training program was successfully held, organized by the Scientific Research Office of China Academy of Art, co-organized by the Creative Connection Laboratory of China Academy of Art and the Segal Design Institute of Northwestern University in the United States.

In 2018, the Shanghai Academy of Fine Arts invited Bahbak Hashemi-Nezhad, to teach a five-day postgraduate course on design thinking at the Royal College of Art in the UK (RCA IN SAFA). The course was designed for first year PhD and Masters students from a range of design disciplines. The course included theoretical instruction on the methodology of Design Thinking as well as practical design challenges (Shanghai University College of Fine Arts,2018). In September of the same year, the Shanghai Institute of Visual Art, in partnership with the d.School at Stanford University in the United States, launched a nine-day design thinking workshop. The curriculum is designed to emphasise interdisciplinary and systematic learning. The instructors came from different disciplinary and professional backgrounds, including Kim Jacobson from Stanford, Chen Hua, CTO of the LUX User Experience Center, Chen Sihan from Taiwan University of Science and Technology's Silicon Valley Innovation Center, and Zou Yiliao from the Visual-DeTao Design School at the Shanghai Institute of Visual Art. The workshop was open to students from all majors at the design college, and only 30 students with strong innovative abilities were selected. The curriculum was divided into two parts: thinking training and design practice. In the thinking training stage, students were guided to use creative thinking methods to analyze, discuss and summarize typical design cases to improve their application of various thinking methods. In the design practice stage, task-driven teaching methods were employed to explore Chinese young people's understanding and attitudes toward local coffee culture, using Luckin Coffee's Internet business model as a case study (Jacobson, Zou, & Lu, 2018).

In addition, as art schools explore new models for cultivating design talent, comprehensive universities are also beginning to explore interdisciplinary talent development.

On April 25, 2013, Tsinghua University established the Tsinghua x-Lab Joint Design Center (School of Environment-Tsinghua University, 2013), an educational platform that integrates creativity, innovation, and entrepreneurship. The "x" in x-Lab emphasizes exploring the unknown and interdisciplinary collaboration, while "Lab" focuses on experiential learning and teamwork. The unique value of x-Lab is reflected in three aspects: promoting interdisciplinary collaboration within the university, integrating external resources, and providing ways and paths for commercialization and social value realization. The laboratory hosts various lectures such as "Art, Creativity, and Design Thinking" and offers a MOOC experience in design thinking training. Leveraging the strengths of the Tsinghua School of Economics and Management, x-Lab offers innovation and entrepreneurship courses and various activities and provides resources and support to promote collaboration among interdisciplinary teams composed of Tsinghua faculty,

students, alums, and external partners. To harness the driving force of design thinking in innovation and entrepreneurship, the Joint Design Center is exploring a new model of integrating innovative thinking and service design into business operations and market development.

In 2017, Tsinghua University and the University of Geneva signed a memorandum of understanding on sustainable development cooperation (Ji & Hua, 2017), officially launching the "Geneva-Tsinghua Initiative" (GTI). Under the GTI, x-Lab and the University of Geneva's SDG Solution Space have implemented a social innovation exchange program (SDG Learning Camp) since 2018 to cultivate international talent for sustainable development innovation (The School of Economics and Management Signed a Tripartite Memorandum of Cooperation with the United Nations Institute for Training and Research and the School of Economics and Management of the University of Geneva, 2021). In 2019, x-Lab successfully introduced the "Open Geneva" innovation marathon challenge, organized by the University of Geneva, to Tsinghua University, incorporating new elements related to the United Nations' sustainable development goals, thus creating a unique Chinese-style creative event called "SDG Open Innovation Marathon Challenge (SDG Open Hack)." In 2020, under the leadership of the Tsinghua University Innovation and Entrepreneurship Education Coordination Committee, the competition and courses were upgraded, becoming a large-scale campus-wide innovation and entrepreneurship practical learning activity.

B. Design thinking as a general course is gradually introduced into the university classroom

a. In Tsinghua University, design thinking is a general education course introduced since 2011-2012 academic year. In 2012, Professor Chen Nan's course "Visual Communication Design Thinking and Methods" was awarded the title of "Tsinghua University's Quality Course." Seven years later, in 2019, the course was again awarded this honor (Chen, 2019). Fig. 1, "Training content of Chen Nan's Visual Communication Design Thinking and Methods" is shown.

In addition to the general education courses, Tsinghua University also carries out innovative design-related practical courses in projects. For example, since January 2015, the "Tsinghua University Creative Design Thinking Ability Improvement Project" has been launched. It is a particular ability improvement project jointly designed by the Academy of Arts and Design and the Graduate School of Tsinghua University. By training creative design thinking and integrating innovative design practice, the project aims to improve students' innovative design thinking ability and cultivate "H"-type innovative talents with high quality, broad vision, and strong capabilities. Students are required to complete at least 10 credits of courses to obtain the "Creative Design Thinking Ability Improvement" project certificate jointly issued by the Graduate School and the Academy of Arts and Design of Tsinghua University (Registration - Tsinghua University Student Innovation Promotion Certificate Program Opened, n.d.).

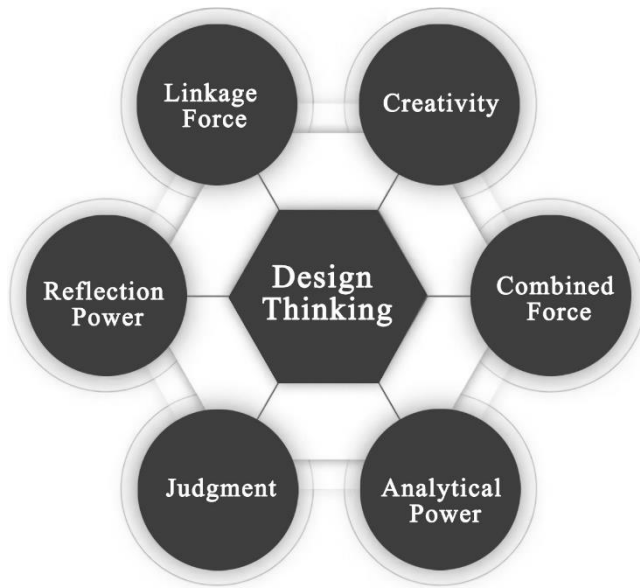


Fig.1. Training content of Chen Nan's Visual Communication Design Thinking and Methods

Table 1. Creative design thinking ability enhancement course module (Tsinghua University Creative Design Thinking Ability Improvement Project, 2020)

Course module	Content	Course type	Credit
Thinking training	Including: design research methods, design culture, Design value and experience, thinking design	Compulsory course	≥3 credits
Capability transformation	Including: integrated and innovative design, design appreciation and evaluation, Design strategy and management, user experience design	Compulsory course	≥3 credits
Ability improvement	Including: Design Innovation Series (1), Design Innovation Series (2)	Compulsory course	≥4 credits

The course is divided into three parts: thinking training, ability transformation, and ability enhancement. Taking the "Design Thinking" course taught by Jiang Hongbin and Qiu Song at Tsinghua University as an example, the course downplays students' professional backgrounds and emphasizes interdisciplinary general education. The course highlights the learning and practice of innovative thinking and methods. Under the guidance of teachers, students undergo stage-by-stage intensive training around different topics to quickly improve their comprehensive innovative abilities. Through knowledge integration, the course content is innovative. By integrating "design innovation" and "business innovation" and based on the characteristics of the industry chain, "innovative thinking" is taken as the primary focus to provide teaching in stages and progressively. Through systematic theoretical learning and classic topic training, students can quickly understand and master the thinking methods and implementation process of "innovation." This new course model is the first among similar courses in China and abroad.

b. The course "Design Thinking and Methodology" was launched in 2014 for the first-year students of the School of Art and Design at the Beijing Institute of Fashion Technology. The course is based on the institute's educational philosophy of "integration of art and technology, inheritance and innovation" and its goal of cultivating high-quality innovative talents. Unlike the traditional mode of a single teacher delivering information, the course is developed collaboratively by more than 20 young teachers and foreign

teachers from different design fields, led by Guo Xiaoye, the director of the Visual Communication Design Department. The course teaches students to think like designers through multi-dimensional and multi-faceted methods. After eight months of research and discussion, the course materials were developed and refined over the past six years. As of now, more than 1540 students have benefited from the course. In 2019, the course won the second prize in the "Excellent Case of Blended Teaching Based on MOOC" selection of the Beijing University Quality Course Research Association and was published as an open course. The textbook, "From Understanding to Discovery: A Course Record Based on Design Thinking for Design Foundation," written by Guo Xiaoye, was officially published in 2020 by China Architecture and Building Press. The course has become a typical case of teaching reform in the institute and the university and has been widely promoted through inter-school exchanges, achieving a good reputation both inside and outside the school. The course's content and teaching methods were promoted at the "International Design Education Forum and Literature Exhibition" in late October 2019, and it won the first Beijing University Quality Undergraduate Course (Key) award. It has become a well-received brand course at the Beijing Institute of Fashion Technology.

c. In the fall of 2020 and spring of 2021, the Future Design and Innovation Research Center at Beijing Normal University offered a public elective course titled "Art and Design Thinking" for undergraduate students in non-art majors at the Zhuhai campus of Beijing Normal University. The course was taught by Gao Peng, the director of the FDC at Beijing Normal University, and covered four main topics: "Brief History of Modern Art," "Brief History of Modern Design," "Development of Design Thinking," and "Foundations of Design Practice." Each semester, Gao Peng invited a new instructor to join the course to expand the content of the "Art and Design Thinking" curriculum. This semester, the course was co-taught with Su Lei, who focused on the history and current state of "New Media Art" to achieve a cross-disciplinary and innovative curriculum.

d. In Shanghai Science and Technology University, the Design Thinking course is mandatory for first-year undergraduate students at the School of Entrepreneurship and Management. It is also a prerequisite course for the Innovation and Entrepreneurship minor, with 48 teaching hours offered three times a year in the spring, summer, and fall semesters. As the first innovative course in China aimed at developing cognitive skills for science and engineering students, Design Thinking combines theory with practice to train students to use scientific methods and critical thinking to identify and solve real-life problems. Students learn to collaborate with team members from different disciplines and apply the five design processes of Perception, Definition, Ideation, Prototyping, and Testing to propose feasible solutions and create project products with practical value and commercial potential.

e. In the spring semester of 2012, the Tianhua College of Shanghai Normal University offered the "Innovative Thinking" general education course for the first time (Shanghai Normal University Tianhua College General Courses Introduction, 2014), targeting all first-year students from various majors, including humanities, management, psychology, art, and engineering. Initially, the course was delivered as lectures, with four teachers giving four lectures each on the aspects of thinking quality, basic psychology, basic logic, and innovative cases. Starting from the spring semester of 2013, the university decided to increase the course credits from 0.5 to 1 and the class hours from 4 lectures to 8 lectures (16 hours), and also carried out significant reforms and explorations in teaching content and teaching methods. Taking the "Design Thinking" course at Stanford University as a learning model, the course underwent a series of reforms and explorations (Nie, 2015).

Regarding course content, the "Innovative Thinking" course has reformed the chapter settings that previously focused on logic, psychology theory, and simple case introductions. The 8-lecture course is divided into two parts: 4 lectures on theory and 4 lectures on practice. The theoretical courses extract cutting-edge thinking theories from domestic and international sources, such as critical thinking and design thinking. The

practical courses are divided into four topics according to the professional settings of Tian Hua College: science and technology, education management, and culture. In terms of task allocation, A teacher (Bachelor of Physics, Master of Science and Technology History) is responsible for the chapters on critical thinking, logical thinking, scientific thinking, and the application of these methods in technological innovation. B teacher (Bachelor and Master of Philosophy) is responsible for the design thinking method and its application in educational, cultural, and management innovation and offers courses on design thinking theory, educational innovation, management innovation, and cultural creativity (Nie, 2015).

According to the general education course introduction of Tian Hua College of Shanghai Normal University in 2014, the innovative thinking course is a compulsory general education course for first-year students and an optional general education course for second-year students and above, such as: opened Hasso Plattner School of Design Series Courses (Stanford University Cloud Course), Science and Innovation, Philosophy and Life, Cloud Era Education (Critical Thinking Training Course), College Student Entrepreneurship, Celebrity Success, Introduction to Philosophy (Fudan University Cloud Course).

Research has shown that design thinking has gradually entered the classroom as a general education course in universities. Some universities have also gradually opened general education courses related to design thinking, such as the "Design Thinking" course offered by the Pan Tian Shou College of Architecture and Art Design at Ningbo University, a compulsory general education course for first-year design majors. In addition, the "Creative Thinking" course is taught by Professor Li Yuan at Jilin Animation College, and so on.

Overall, design thinking emphasizes exploring thinking patterns, levels, and methods and has strong practical training and real-world application value. As a general education course introduced into university teaching, it has effectively supplemented traditional professional teaching and has deep significance and the necessity for cultivating students' logical and visual thinking skills.

C. The development of the MOOC has promoted the promotion of design thinking online courses

With the development of the MOOC, design education is also slowly moving towards the Internet. As a general education course for design education, a series of online courses have also been opened in line with the times so that more people can benefit from it.

The future-oriented Internet University initiated by Tsinghua University has opened courses such as "Visual Communication Design Thinking and Methods," "Design Thinking," and "Creative Thinking" so that more students have the opportunity to learn the theory and methods of design thinking systematically.

On September 25, 2015, the course "Visual Communication Design Thinking and Methods" developed by the team of Professor Chen Nan of Tsinghua University was listed in Tsinghua MOOC (Chen, 2023). The course focuses on the teaching of logical thinking and reverse thinking. Take design philosophy, research-based design, cross-border design, and metrical design as the macro perspective, and master the ability to choose which design thinking and design method to carry out the practice.

The "Design Thinking" course developed by the team of Professor Liu Jingwei from Xi'an Polytechnic University aims to explore the essence of design and design from the needs of life(Liu, 2023) and design a series of thinking training experiments from the essence of manufactured objects. In different scenarios, follow the law of cultural occurrence and development, and develop students' innovation and creative design through the thinking processing of learners.

The "Creative Thinking" course offered by Wang Xin's team at Guangdong University of Finance and Economics is based on the concept of "breaking through models, digging deep into potentials (Wong et al., 2016), pursuing new concepts, and seeking new presentations", with "creative ability shaping" as the core, teaching creative thinking methods, Taking "local cultural cognition and creative expression development" as the carrier, it highlights knowledge, culture, high-level, practicality and innovation, ignites students' enthusiasm for exploration and innovation, and obtains innovative results.

Table 2. Table of online course system of design thinking in three universities

Topic	Tsinghua University Visual Communication Design Thinking and Methods	Xi 'an Polytechnic University Design Thinking	Guangdong University of Finance and Economics Creative Mind
Topic 1	Design thinking and methodology a. The influence of design philosophy and design aesthetics on design thinking b. Interpretation of design concepts and definitions c. The basic quality training of designers and the evaluation criteria of design	Introduction a. Space for design thinking b. Thinking and design technology c. Tools of design thinking d. Knowledge system of design thinking e. Learning mode of design thinking	Introduction
Topic 2	Design thinking and methods Keyword interpretation a. Definition and the dimension of design b. Design inheritance and innovation c. The design of creating value (Case study)	Design model: a. Character model b. User model c. Product model	Sources of ideas Speech creativity Source of creativity Life and creativity
Topic 3	The thinking and method of "metrical design" a. "Case" and "pattern" b. Principle of "metrical design" c. Case study of "Metrical design"	The joys and sorrows of life and design a. Activities b. Emotion c. Interesting	Characteristics of creativity From the perspective of ROI theory, creativity, originality, relevance, simplicity, surprise, concrete, credibility, emotion
Topic 4	Diversity of design thinking a. Diverse design thinking and case analysis b. New approach to Chinese character design Research (case in-depth interpretation)	How can life be designed in the future a. Man-made things b. Diachronic method c. Vision	The energy of creative thinking a. Thinking and creativity b. Creative thinking model c. Barriers to creative thinking
Topic 5	Teaching Case of design thinking and Method Case study of subject Training (1, 2, 3)	Innovation and creativity based on cultural production a. Culture	Creative tool: Lateral thinking method a. De Bono's lateral thinking method b. Essential conditions

		b. Language c. Language modes	for applying lateral thinking c. Experience lateral thinking method
Topic 6	Concepts of Design Thinking and Methods	Aesthetics a. Aesthetic sense b. Common sense c. Style	Creative Tool: Mind Mapping a. Tony Buzan's Mind Mapping b. Advantages of Mind Mapping c. Experience Mind Mapping
Topic 7	Design Thinking Models	Design Ideologies a. Machine-Centered Ideology b. Humanism c. Functionalism	Creative Tool: Brainstorming a. Concept and Purpose of Brainstorming b. Essence and Development of Brainstorming c. Techniques and Evaluation of Brainstorming d. Experiential Brainstorming
Topic 8	Design Thinking Salon: Talk and answer questions with students of the Academy of Fine Arts	Implementation of design Science, art, and technology	Techniques for Creative Development a. Seeking Divergence from the Essence of the Problem b. Sketching: A Method of Thinking with Hands c. Empathy through Perspective-taking
Topic 9	Design Philosophy: The Unity of Knowledge and Action	Who will judge the fruits of labor Evaluation, work, product	Project presentation: Tell the world "Who I am"
Topic 10	Comments and conclusions	Market Experience, setting, character.	Extension and expression of creative thinking a. Design and exploration of sustainable packaging -- material, packaging shape design, structure design b. Local culture mining and innovation c. Digital development of Lingnan folk roles
Number of online learners (Up to 2023/4/17)	119799 people	12260 people	14899 people

Through research, it has been found that in addition to the data in the above table, taking China's MOOC platform as an example, for the Zhejiang University's "Design Thinking and Innovative Design" course taught by Zhang Kejun, Sun Lingyun, and Chai Chunlei, 79061 people participated and it was awarded the "National Excellent Course" title; for the Xi'an University of Posts and Telecommunications' "Design Thinking Methods and Innovative Practice" course taught by Zhao Guangyuan, 3700 people participated; and for the Beijing University of Posts and Telecommunications' "Innovative Design Thinking" course taught by Sun Wei, 8456 people participated, etc. (The above data is also constantly changing).

Table 3. Three Chinese universities offering design thinking courses in MOOC

University	Course title	Instructor	Number of courses	Total Number of Students (as at 2023/4/17)
Zhejiang University	Design thinking and innovative design	Zhang Kejun, Sun Lingyun, Chai Chunlei	10	79061
Xi 'an University of Posts and Telecommunications	Design thinking method and innovation practice	Zhao Guangyuan	5	3700
Beijing University of Posts and Telecommunications	Innovative design thinking	Sun Wei	4	8456

Using data analysis, various universities may be actively researching the framework and course design of design thinking online courses, based on the characteristics of their respective regions. This has led to "diverse opinions and a proliferation of ideas." As a new form of education, MOOC has the characteristics of openness, large-scale participation, and interactivity. More importantly, it is free and breaks down the barriers between universities. It focuses on "students-centered" teaching, allowing students to enjoy top-quality teaching resources and fully reflecting the fairness of education. However, through the analysis of online learning data, it can be seen that well-known universities such as Tsinghua University and Zhejiang University have a clear advantage in reputation and are more popular among students. Other ordinary universities, whether actively or passively involved in the "competition" of MOOC, also actively explore course resources, teaching methods, and innovation. This "Internet +" wave has triggered active competition among universities and encouraged the reform of art and design teaching at higher learning institutions.

International Best Practices in Design Thinking Courses

Courses in design thinking are implemented in more and more interdisciplinary fields, and their teaching in universities and higher education institutions have also grown substantially. However, design thinking courses show different characteristics, such as creative courses, innovative courses, innovative design courses based on the PBL teaching method, etc.

A. Stanford University (Creative curriculum)

The idea behind Stanford University's "Design Thinking" course originated from David Kelly, the founder of the design company IDEO. In 2004, he launched and established the Stanford University School of Design (D. School). In 2005, after receiving a donation from the founder of SAP, Hasso Plattner, the Stanford University School of Design was officially established.

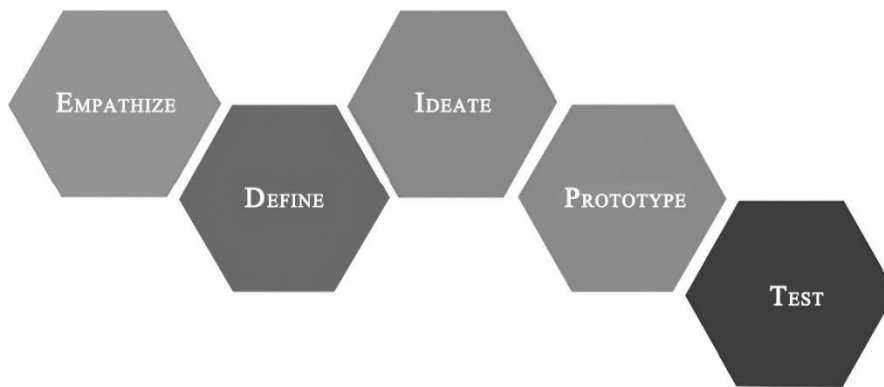


Fig. 2. Design Thinking Stanford D-School

Stanford University's teaching reform based on design thinking focuses on "interdisciplinary collaboration." The course aims to cultivate "design thinking" as its core and hopes that students from different fields (including management, design, social sciences, computer science, medicine, etc.) can work together in a studio environment under the guidance of different teachers and industry experts. The goal is to combine design with a range of social issues and use design thinking to solve practical problems. At the same time, they strongly emphasize practical skills, emphasizing "learning by doing" and advocating that "projects are experiential learning." They believe that only hands-on experience and action can produce solutions that can be tested and adjusted according to user needs. The open and free learning space also positively promotes innovation, where teachers and students can design and transform the space layout according to their needs to stimulate their creative thinking abilities.

B. University of Miami (Creative curriculum)

The Miami Design Collaborative (MDC) at the School of Creative Arts, University of Miami, launched the Design Thinking Certificate program. This interdisciplinary design program brings together students and faculty from various fields to cultivate professional knowledge in design thinking, explore problem-solving through teamwork and apply knowledge outside the classroom. The Design Thinking Certificate is designed for students interested in the process and principles of design thinking and who want to work collaboratively to solve problems.

The Innovation, Creativity, and Design Thinking (SCA111) course will lead students to explore the origins of innovative ideas and their role in various fields throughout human evolution. Students will experience multidimensional creativity and innovation, core features of human capabilities, from individual growth, change, and adaptation to survival as a species. The course will help students understand how to apply creative ideas to scientific methods and experience the process of innovation through a range of media and projects. Learning about the role and process of innovation and design thinking is the core of the course. Students will develop teamwork, problem-solving, and leadership skills while experiencing wealthy individual and collective creativity opportunities.

C. Royal College of Art (Creative curriculum)

In a research project called "Design Education for All" conducted by the Royal College of Art (RCA) in the UK, design education is proposed as a discipline on par with science and humanities, and design as a third type of general education is considered necessary and reasonable. The academic research of RCA upholds the values of "innovative culture," "reflective culture," and "openness," which have led to the cultivation of influential figures in the field of art and design in different eras.

Regarding educational philosophy, RCA has always focused on student-centered education, adjusting professional design programs according to society's and the market's needs. The college is relatively flexible in this regard, and any new courses are subject to a rigorous quality assurance review before they can be established.

In terms of teaching methods, RCA commonly uses heuristic teaching to inspire students' professional skills, including interpersonal communication, academic lectures, and problem-solving skills.

D. Vanderbilt University (Innovative curriculum)

Vanderbilt University (University Course – Design Thinking, Design Doing | Center for Teaching | Vanderbilt University, n.d.) offers an introductory course in design Theory and practice for undergraduate juniors and seniors as an elective for credit, which can be applied to all of the university's School of Arts and Sciences, Blair School of Music, School of Engineering, School of Medicine, School of Nursing, and Graduate School. This course is an undergraduate degree elective course in the School of Education. As a graduate degree elective course, it covers education policy, Community Development and Action, International Education and Policy Management, Learning, Diversity, Urban Studies, reading education, Learning and Design, Leadership and organizational performance, and secondary education.

The course is named after "Design Thinking, Design Doing UNIW 3350/5350", The "Design Thinking" component of the course guides students to understand how people interact with society and the environment critically, and the "Design Behaviour" component guides students to create intentional interventions that result in relationships that are more meaningful and productive. The course adopts the concept of "people-oriented" design and uses the "user perspective" to participate in the design process to think about the design. Students learn knowledge, methods, and skills in this process.

Students learn mainly by working in teams on design projects and researching issues in areas such as education, business, and health. Consisting of lectures, discussions, readings, and classroom exercises, the course encourages students to reflect on their design processes and insights through a series of formal studies of design literature. Students will devote hours observing, listening, analyzing, storyboarding, and inviting users to participate in the experience as they develop and implement valuable transformative designs.

After years of practice, the course has shown the following four typical characteristics: (1) The course is an introduction to design and design theory and practice. Through the concept of "people-oriented," students will produce designs with a sense of situational response. (2) The course focuses on user analysis and situational analysis and uses design theory to find user needs. At the same time, iterative rapid experimentation-prototyping-user testing. The ultimate goal is not to "find" a solution but to develop a suitable solution that meets the user's needs and the environmental conditions constraints. (3) The course is implemented project-based, and the project focuses on user needs (or need-knower). Students invest hours observing, listening, analyzing, storyboarding, learning, and experiencing design as they develop and implement valuable transformative designs. (4) Students will learn in interdisciplinary and inter-grade project teams, the projects will serve real clients, and the design works will be delivered at the end of the semester.

E. Tama Art University (Innovative design course based on PBL teaching method)

Through exploration of design education in Japan, it has been found that to improve students' design skills, design projects are incorporated into design teaching, and the results obtained by students through simulated real-world scenarios are particularly remarkable. This is the famous "PBL" design teaching model. Tama Art University applies the PBL teaching model to deepen the development and implementation of design thinking courses.

Since 2006, Tama Art University has been implementing a practical, participatory, and project-based "PBL" teaching model, which focuses on students as the subject of teaching, problem-solving as the basis of teaching, and improving professional skills and comprehensive application capabilities as the ultimate goal.

The course schedule shows that most courses are open to students from different grades and majors, focusing on interdisciplinary education to broaden and deepen their knowledge. The organizational structure also emphasizes cooperation and collaboration between different majors, requiring teachers to transform their role from "lecturers" to "guides," helping students construct practical problems and meaningful tasks.

Moreover, Tama Art University's "PBL" teaching model integrates industry, academia, and research. It not only has the characteristics of interdisciplinary and cross-grade learning but also organizes PBL results exhibitions and conferences each year, strengthening its connection with society, enterprises, and the government and promoting the improvement and growth of the "PBL" model.

Table 4. Examples of Universities & Graduate Schools Implementing Design Thinking Education (Kurokawa, 2013)

Asia-Pacific Region	
Australia	University of Technology, Sydney
China	Zhejiang University; Communication University of China†
India	National Institute of Design* Indian Institute of Technology
Japan	Kyushu University (Graduate School of Design) Kyoto Institute of Technology (Department of Design Engineering & Management) Keio University (Graduate School of Media Design, Graduate School of System Design and Management) Chiba Institute of Technology (Department of Design) Tokyo Institute of Technology (Graduate School of Design Science and Technology) The University of Tokyo (i.school) Tokyo City University (Social Information Department) †
Singapore	Singapore University of Design and Technology Singapore Polytechnic National University of Singapore
South Korea	KAIST (DESIGN)*
China Taiwan	Xue Xue Institute
South America & North America	
Chile	Pontificia Universidad Catolica de Chile
Canada	University of Toronto (Rotman School of Management) *
United States	Stanford University (HPI d.school)* Northwestern University* Massachusetts Institute of Technology (System Design Management) Illinois Institute of Technology (Institute of Design) *
Europe	
Denmark	Technical University of Denmark Design Skolen Kolding
Finland	Aalto University (IDBM)*
France	The École des Ponts ParisTech (d.thinking)

Germany	University of Potsdam (HPI d.school)
Italy	Milan Institute of Technology
Netherlands	Delft University of Technology* Technische Universiteit Eindhoven
United Kingdom	Royal College of Art / Imperial College London*

*Indicates universities and graduate schools presented by Business Week (2009). † It identifies a college or graduate program that will start classes in the 2013–2014 school year. To varying degrees, the universities and graduate programs on this list are incorporating design thinking curriculum.

Lessons and Implications for University General Education Curriculums

Table 5. Application field of design thinking and experience for reference (Hu & Zhu, 2018)

Country	Application advantage	Experience for reference
America	Integrating design thinking into classroom teaching is helpful to build a "student-oriented" classroom and promote the development of students' higher-order thinking abilities.	In teaching, attention should be paid to teachers' application of design thinking and students' mastery of design thinking. Promote the development of students' innovative ability and problem-solving abilities in exploration and design activities. Provide effective information technology tool support for each link of the design.
Australia	Use design thinking to improve the quality of online courses and help normal university students master the methods of online course design.	Design online/offline courses with design thinking concepts and methods. Design online course learning activities according to the design thinking model. Establish an effective connection between design thinking learning and application.
Japan	Use a design thinking system to diagnose school education problems and solve them accordingly.	Introduce design thinking into diagnosing daily problems in schools, and innovate ways to solve problems in school education and teaching. Make complete reference to the design thinking model, but do not have to copy its original operating processes and steps rigidly. Focus on the training of design thinking ability for school administrators and teachers.

A. People-oriented, social issue-focused design thinking

Design thinking emphasizes people-oriented solutions and focuses on social problems (Brow, 2008), which can help cultivate students' humanistic feelings and social responsibility. The core philosophy of design thinking is centered on putting people first, meaning that when solving problems, it is essential to deeply understand users' needs, thoughts, and behaviors to create solutions that genuinely meet their needs. This people-oriented approach can help students develop the ability to care about and understand others and empathize with them. Furthermore, design thinking emphasizes addressing social issues, which can guide students to gain a deeper understanding of the realities and problems facing society and inspire them to have a sense of social responsibility and enthusiasm for making a positive impact.

Introducing design thinking into college general education courses can enable students to become more closely connected to real-world social problems, cultivating their courage

and ability to tackle complex issues. This approach can help students enhance their problem-solving skills and foster their innovative mindset and interdisciplinary thinking ability [26], laying a solid foundation for their future careers. Design thinking can also develop students' aesthetic and creative abilities, which are critical for enhancing their overall quality and humanistic education.

B. Interdisciplinary collaboration and cooperative empathy

Interdisciplinary collaboration is one of the core elements of design thinking. In design thinking, solving problems requires integrating knowledge and experience from different science-related fields and disciplines, including applied sciences, computer sciences (Wong et al., 2016), and social sciences. The integration brings together different perspectives and ways of thinking to think and solve problems. This interdisciplinary collaborative approach can help students better understand and apply the knowledge of different disciplines and broaden their knowledge and vision. At the same time, this method can also cultivate students' ability to cooperate and empathize, stimulate students' teamwork spirit, and promote communication and cooperation between students. In future career development, this ability of interdisciplinary cooperation is also essential because many practical problems need to be solved by various knowledge and skills.

C. Practical problem-solving skills and creativity

Design thinking is aimed at practical problems facing the real world, which can stimulate students' curiosity and creativity and help cultivate students' problem-solving abilities. As Smith found through comparative study, compared with traditional digital manufacturing courses, integrating design thinking into them can help promote the development of student's creative ability and complex problem-solving ability, and the digital products designed are more conducive to solving problems in real situations (Smith et al., 2015).

Design thinking cultivates students' "problem-solving ability, practical innovation ability, and comprehensive transboundary ability" (Guaman-Quintanilla et al., 2023). Therefore, a design thinking course is an effective method and way to improve the level of design thinking of college students and change the current teaching mode. It is not only for students majoring in design but also suitable for training various types of majors. At the same time, it also has an important impetus for developing enterprises.

Conclusion

In conclusion, the implementation of design thinking education in college general education courses has the potential to significantly impact the development of sustainable education and enhance the competitiveness of national industries. The paper explored the current status of design thinking education in China and presented international best practices of design thinking courses, highlighting the importance of interdisciplinary collaboration, practical problem-solving, and cultivating humanistic feelings and social responsibility. The key lessons and implications of design thinking education for university general education curriculums have also been discussed, emphasizing the importance of people-oriented, social issue-focused calculative thinking, interdisciplinary collaboration, practical problem-solving skills, and creativity. Ultimately, the adoption of design thinking education across a wide range of disciplines and industries has the potential to cultivate innovative and practical problem-solving skills among college students and promote sustainable development in education.

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