

DEVELOPMENT OF A COLLEGE
INTERDISCIPLINARY TEACHING
MODULE FOR HIGHER
ORDER THINKING
SKILL

UNIVERSITI PENDIDIKAN SULTAN IDRIS

2025

DEVELOPMENT OF A COLLEGE INTERDISCIPLINARY
TEACHING MODULE FOR HIGHER
ORDER THINKING SKILL

DING ZHENDUO

THIS THESIS PRESENTED TO QUALIFY FOR A DOCTOR OF PHILOSOPHY

FACULTY OF HUMAN DEVELOPMENT
UNIVERSITI PENDIDIKAN SULTAN IDRIS

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ABSTRACT

This study aims to design and develop an Interdisciplinary Higher-Order Thinking Module (IHTM) to support interdisciplinary teaching in Chinese colleges. Using a Design and Development Research (DDR) approach, the study was conducted in three phases. In phase one, the respondents involved 367 students and eight teachers, a survey on the current status and needs of interdisciplinary higher-order thinking (HOT) teaching was conducted using the interdisciplinary HOT questionnaire (IHTQ) and semi-structured interview protocol (SIP). In phase two, the respondents were 13 experienced interdisciplinary education experts, who reached a consensus on the module components through the Delphi method, based on this consensus, the IHTM was designed and developed. In phase three, the respondents were 37 college teachers, for whom a usability questionnaire (QMUT) was designed based on the Technology Acceptance Model (TAM) to evaluate the module's usability. In this study, qualitative data analysis was conducted using thematic analysis, while quantitative data analysis included descriptive statistics, independent samples t-test, paired samples t-test, u-test, and triangular fuzzy analysis. The findings indicate that the IHTM has high usability (Cut-off point > 3.68), and the expert panel reached a consensus on the module's usability (Fuzzy score > 0.5). IHTM's high ease of use ensures its adaptability in college education, making it an effective tool for interdisciplinary HOT teaching. As a referable module for interdisciplinary HOT teaching, the development of IHTM provides Chinese college teachers with practical insights and a structured DDR approach to enhance interdisciplinary module design. Additionally, it aligns with Chinese education policies and offers policymakers meaningful perspectives for higher education reform.





PEMBANGUNAN MODUL PENGAJARAN ANTARABIDANG DI PERINGKAT KOLEJ BAGI KEMAHIRAN BERFIKIR ARAS TINGGI

ABSTRAK

Kajian ini bertujuan untuk merancang dan membangunkan Modul Pemikiran Tingkat Lanjut Interdisipliner (IHTM) untuk menyokong pengajaran interdisipliner di kolej-kolej China. Menggunakan pendekatan Penyelidikan Reka Bentuk dan Pembangunan (DDR), kajian ini dijalankan dalam tiga fasa. Dalam fasa pertama, responden yang terlibat adalah 367 pelajar dan lapan guru, di mana satu tinjauan mengenai status semasa dan keperluan pengajaran pemikiran tingkat lanjut interdisipliner (HOT) telah dijalankan menggunakan soal selidik HOT interdisipliner (IHTQ) dan protokol temu bual separa berstruktur (SIP). Dalam fasa kedua, responden adalah 13 pakar pendidikan interdisipliner yang berpengalaman, yang mencapai konsensus mengenai komponen modul melalui kaedah Delphi, dan berdasarkan konsensus ini, IHTM direka dan dibangunkan. Dalam fasa ketiga, responden adalah 37 guru kolej, untuk mereka, soal selidik kebolegunaan (QMUT) direka berdasarkan Model Penerimaan Teknologi (TAM) untuk menilai kebolegunaan modul tersebut. Dalam kajian ini, analisis data kualitatif dijalankan menggunakan analisis tema, manakala analisis data kuantitatif melibatkan statistik deskriptif, ujian t sampel bebas, ujian t sampel berpasangan, ujian u, dan analisis kabur segitiga. Dapatan kajian menunjukkan bahawa IHTM mempunyai kebolegunaan yang tinggi (Titik potong > 3.68), dan panel pakar mencapai konsensus mengenai kebolegunaan modul (Skor kabur > 0.5). Kemudahan penggunaan IHTM yang tinggi memastikan kesesuaiannya dalam pendidikan kolej, menjadikannya alat yang berkesan untuk pengajaran HOT interdisipliner. Sebagai modul rujukan untuk pengajaran HOT interdisipliner, pembangunan IHTM menyediakan guru-guru kolej China dengan pandangan praktikal dan pendekatan DDR yang tersusun untuk meningkatkan reka bentuk modul interdisipliner. Selain itu, ia selaras dengan dasar pendidikan China dan menawarkan perspektif yang bermakna kepada pembuat dasar untuk reformasi pendidikan tinggi.



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LIST OF ABBREVIATIONS

CVI	Content Validity Index
FDM	Fuzzy Delphi Method
HOT	Higher Order thinking
HOTS	Higher Order thinking skills
MOE	Ministry of Education
PBL	Project-based learning
OECD	Economic Co-operation and Development
STEM	Science, Technology, Engineering and Mathematics
TAM	Technology Acceptance Mode



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CHAPTER 1

INTRODUCTION

1.0 Introduction



The world today is a reflection of how the various disciplines are integrated. We can see quantum technology applied to communications, computers, encryption technology. We drive a new generation of cars equipped with new energy sources and equipped with artificial intelligence. Our climate problem needs to be discussed by experts from multiple fields. All of this requires multidisciplinary collaboration and higher-order thinking skills, which also puts forward new requirements on college students. Halpern (2021) indicates that higher-order thinking skills are an advanced general ability that citizens must possess in the 21st century.

Over the past 100 years of the Nobel Prize, 41% of achievements have been interdisciplinary, with the proportion exceeding half in the 21st century (Wu & Xu,





2023). Additionally, a study of 88,000 high-quality scientific and technical papers found that interdisciplinary innovation has become a core trend in global science and technology development (Gates, Ke, Varol & Barabási, 2019). Scientific breakthroughs and major technological innovations increasingly emerge from interdisciplinary fields, and expertise in a single domain is often insufficient to solve complex problems, necessitating a more integrated knowledge structure and skill set for future innovators (Ni et al., 2021).

To adapt to these changes, college education has been gradually breaking through disciplinary boundaries. Since the 1970s, interdisciplinary education has received increasing attention, with scholars exploring its theoretical foundations and recognizing it as a key element of higher education reform (Chen & Xu, 2018).

Research suggests that interdisciplinary instructional design enhances student competitiveness, developing creativity, problem-solving, and the ability to learn independently (Drake & Reid, 2020; Bintz & Monobe, 2018). Drake and Reid (2020) further assert that interdisciplinary life skills are essential for adapting to the evolving demands of the contemporary workplace.

However, Chinese higher education remains highly discipline-centric, hindering the advancement of interdisciplinary education. Rigid disciplinary structures and fragmented research efforts within universities create challenges for knowledge integration and cross-disciplinary collaboration (Pan & Sun, 2021). This restricts students' capacity to develop higher-order thinking skills, a fundamental ability in today's rapidly changing information and technology landscape. The





absence of these skills presents a significant barrier to the intellectual and professional growth of college graduates.

Interdisciplinary education strengthens knowledge integration and fosters higher-order thinking skills (Li, 2021). Students trained with interdisciplinary pedagogies that emphasize problem-solving and critical thinking are highly sought after by top universities and major industries (Zahroh, Sari & Nulinnaja, 2018). Therefore, this study aims to analyze interdisciplinary education paradigms, develop interdisciplinary teaching modules tailored to Chinese education, and evaluate their impact on enhancing students' higher-order thinking skills. This chapter describes the background of the study, problem statement, purpose of the study, objective, research framework, significance, operational definitions, and its limitations.



1.1 Brief Overview of Shandong region education

Given that the region where this study was implemented is Shandong Province, China, it is necessary to discuss the current situation, background and policy support related to interdisciplinary teaching and HOTS in colleges.

1.1.1 Basic information of Shandong Province

Shandong, a historically and economically significant province, is located on China's eastern coastline. Jinan, the provincial capital, serves as the center for education and





higher learning, bringing together students from 17 cities. China's education system follows a nationally standardized structure, with nine years of compulsory education, followed by high school and the college entrance examination. Higher education in Shandong aligns with national policies, focusing on holistic student development, adaptability to technological advancements, flexible learning pathways, and practical application of knowledge (China State Council, 2019; Ma, 2022).

1.1.2 Education and humanities in Shandong

As the birthplace of Confucianism, Shandong's cultural traditions shape its education system. Confucian values emphasize collectivism, respect for authority, and adherence to established norms, often limiting independent thinking and self-expression in classrooms (Guan, 2021). While modern education increasingly promotes student-centered learning and critical thinking, the actual implementation remains limited.

1.1.3 High School Education System and College Entrance Examination Reform in Shandong Province

For many years, China's high education system divided students into arts and science tracks, requiring them to make career-defining choices at age 15. This rigid structure hindered interdisciplinary learning, prompting education reforms. The Ministry of Education abolished the arts-science division, requiring students to study all six core subjects (politics, history, geography, physics, chemistry, and biology) and select three for their college entrance exams, alongside compulsory math, Chinese, and





English. Since 2017, Shandong's new entrance exam policy has reinforced multidisciplinary literacy, ensuring students receive a balanced humanities and science foundation before entering college, which benefits interdisciplinary learning. As a result, students have a more adequate foundation of humanities and scientific knowledge to receive the interdisciplinary modules in the first year of college.

1.1.4 Policies and Practices in Shandong Region on Supporting Interdisciplinary Education

In order to implement the Ministry of Education's policy on comprehensive student development, the Shandong Provincial Department of Education (2021) has started to implement interdisciplinary assignments and the Shandong Provincial Institute of Education Science (2022) has launched a collection of interdisciplinary teaching cases to enrich the content and teaching strategies of interdisciplinary teaching, however, these are only for primary and secondary schools, and there is a lack of exploration in college teaching practices.

Therefore, in order to meet the national and regional educational development and policy tendencies, and to fill the gap in related fields, this study aims to develop an interdisciplinary teaching model for college use in Shandong to enrich students' cognitive and thinking skills.





1.2 Background Research

Interdisciplinary Education

Interdisciplinary education fosters T-shaped individuals—those with deep expertise in a field while possessing broad knowledge across disciplines. It enhances higher-order thinking and cross-boundary abilities by transcending traditional academic silos (Xu, 2021).

The U.S. pioneered interdisciplinary education in the mid-20th century, with growing interest in recent years (Ma, 2021; Megan & Allen, 2022). Top universities like Stanford have established interdisciplinary research centers across diverse fields, integrating academia with industry to tackle real-world challenges (Zeng & Si, 2020).

Countries like the UK and Japan have also developed distinct interdisciplinary training systems, giving rise to models such as STEM, STEAM, and Maker Education (Jia, Zhou & Zheng, 2021).

China's education policy emphasizes holistic student development, as outlined in the Core Qualities for Student Development (Ministry of Education, 2016). However, disciplinary barriers in Chinese colleges hinder integration, limiting students' exposure to interdisciplinary learning. This is reflected in the low employment rate (55%) among graduates in their major fields and a rigid curriculum that does not foster critical and creative thinking (Wang, 2022).

While interdisciplinary education is still in its early stages in China (Zhang, 2019), national policies increasingly advocate for it. The Overall Plan for





World-Class Universities and Disciplines (2015) and Guiding Opinions on First-Class University Construction (2018) emphasize breaking disciplinary boundaries, integrating resources, and promoting cross-discipline learning (Ministry of Education, 2018). The Natural Science Foundation established an Interdisciplinary Science Department (2020), further reinforcing interdisciplinary development.

The 2023 Deepening Action Programme for Educational Curriculum and Teaching Reform (General Office of the Ministry of Education, 2023) called for integrating foundational subjects (math, physics, chemistry) with emerging fields (AI, aerospace, life sciences). This policy shift underscores the importance of interdisciplinary pedagogy and aligns directly with this study's objective to develop interdisciplinary teaching modules that enhance higher-order thinking skills.



Higher-Order Thinking

21st-century education demands creative, critical, and problem-solving skills (Umam & Dafik, 2019). HOTS includes analytical reasoning, innovation, and decision-making, essential for students' adaptability (Wulan, Susanti & Aisyah, 2017). China has recognized HOTS in policies such as the Opinions on Deepening Curriculum Reform (2014) and China's Core Literacy for Student Development (2016), emphasizing problem-solving, critical questioning, and rational thinking. The 2019 Undergraduate Teaching Reform further prioritized developing high-order and innovative curricula (Ministry of Education, 2019). However, implementation remains inconsistent, with a significant gap between policy objectives and actual classroom practices (Prashant Loyalka, Liu & Li, 2021).





Factors such as academic climate, rigid teaching methods, and recent shifts to online learning (due to COVID-19) have weakened students' engagement in problem-solving and peer discussions, key components of HOTS development (Fu, 2015). A more practical, interdisciplinary approach is needed to bridge this gap.

The rapid development of artificial intelligence (AI)

With AI's rapid advancements, interdisciplinary knowledge is becoming increasingly essential. The 2017 AI Development Plan outlined cross-disciplinary AI research, integrating neuroscience, mathematics, physics, and engineering to drive innovation (Zhuang et al., 2020). AI requires not just technical proficiency but also interdisciplinary problem-solving skills, making HOTS crucial for future professionals (Kusters et al., 2020).



In the context of rapid development of AI, education demands students to pose complex questions and analyze solutions critically (Arandjelović, 2021). The ability to formulate meaningful inquiries, rooted in interdisciplinary knowledge, will be a defining skill of the future. This reinforces the importance of HOTS and interdisciplinary learning in shaping adaptable, forward-thinking graduates, a core focus of this study.

In 2023, Artificial Intelligence is expanding rapidly, shaping both personal and professional spheres. This growth heightens the need for interdisciplinary knowledge and higher-order thinking skills. Kusters et al. (2020) emphasize AI's broad impact across disciplines, urging education systems to integrate AI literacy and interdisciplinary learning to prepare students for an AI-driven world.





As AI increasingly permeates daily life, mastering question-posing and problem-solving skills becomes crucial (Arandjelović, 2021). These abilities, tied to higher-order thinking skills like creativity and critical analysis, are essential for students to navigate evolving technological landscapes. This underscores the importance of interdisciplinary education in shaping future-ready graduates, making both educators and students key players in this transformation.

1.3 Problem Statement

Addressing complex societal challenges such as economic sustainability, environmental preservation, and technological advancement requires interdisciplinary knowledge and higher-order thinking skills (Qiu, 2020). The ability to synthesize diverse knowledge domains, think critically, and solve problems creatively is essential for modern students to navigate an increasingly interconnected and rapidly evolving world. Consequently, interdisciplinary education has emerged as a key pedagogical approach, equipping students with the necessary competencies to tackle multifaceted real-world issues.

Interdisciplinary education has demonstrated significant benefits, particularly in enhancing students' cognitive skills such as critical thinking, evaluation, analysis, adaptability, and teamwork (Holley, 2017; Lattuca et al., 2004). Studies indicate that interdisciplinary learning improves knowledge application, creativity, and problem-solving abilities, while also fostering greater tolerance for ambiguity and sensitivity to ethical considerations (Suliman, Nazri & Nazeri, 2017). Moreover,





industry leaders emphasize the growing importance of interdisciplinary skills — including strategic thinking, creative problem-solving, and communication — for workforce readiness in the 21st century (Greef et al., 2017; Levy & Cannon, 2016, as cited in Allen, 2022). Additionally, interdisciplinary teaching has been found to increase student engagement, motivation, and comprehension, offering a more integrated and meaningful learning experience (Harris, 2019).

Despite its advantages, interdisciplinary teaching remains underdeveloped in Chinese higher education. While 84.5% of students recognize its importance, only a limited number of institutions offer such programs, and existing courses often lack appeal and effectiveness (Leng, 2018). Among students who take interdisciplinary courses, 60.1% find them unengaging, and 79.8% perceive that educators fail to prioritize interdisciplinary approaches. Additionally, graduates feel inadequately prepared for the workforce, citing a lack of broad knowledge integration during their studies (Ministry of Education, 2019).

Another pressing issue is the stagnation in higher-order thinking skills among Chinese students. Research indicates that Chinese college students exhibit minimal growth in critical thinking abilities throughout their academic years. A comparative study by Loyalka et al. (2021) found that while U.S. students showed significant gains in higher-order cognitive skills (0.5 SD increase), Chinese students displayed negligible improvement (-0.3 to 0 SD). Yu (2019) further supports this finding, noting that among 724 surveyed students, higher-order thinking skills remained weak, with a tendency to decline post-admission.





The limited adoption of interdisciplinary education in China is partly due to challenges faced by educators. Studies show that while 70.3% of educators value interdisciplinary learning, 51.2% hesitate to implement it, citing insufficient resources, rigid course structures, and lack of interdisciplinary training (Yang et al., 2024). Many teachers are unfamiliar with interdisciplinary teaching methodologies, leading to ineffective curriculum design and delivery (Huo & Han, 2024). Institutional challenges, including departmental resistance, rigid administrative structures, and inadequate faculty collaboration, further limit the expansion of interdisciplinary programs (Hannon et al., 2018).

The Confucian-influenced education system also plays a role, with rote memorization, teacher-centered classrooms, and a lack of student participation contributing to the underdevelopment of critical thinking and problem-solving skills (Guan, 2021). Observations of Chinese students abroad reinforce this issue, as they tend to be less engaged in discussions and hesitant to challenge authority, limiting their ability to develop independent and creative thought (Streich, Selke & Saito, 2020; Du, 2020).

In the face of the era brought about by the continuous advancement of technology, higher-order thinking skills of college students are more important in the context of employment and social pressure. As discussed earlier, under the conflict between traditional knowledge learning and the explosive development of AI applications, it is more beneficial for students to have higher-order thinking styles in order to apply AI tools, and the birth of generative AI, such as ChatGPT, has led to a shift in the mode of education towards cultivating higher-order abilities such as





innovation, problem solving, and critical thinking (Dai, Zhao & Zhu, 2023). It can be seen that in the future, it is an inevitable trend to utilise more technological tools to solve problems and bring about progress in students' academic life as well as after their employment, and it is even more important for students to learn to ask questions and solve problems.

The lack of higher-order thinking skills (HOTS) among Chinese students has been widely debated. Many argue that Chinese students, particularly those studying abroad, exhibit low participation in discussions and weak critical thinking skills (Guan, 2021). The teacher-centered classroom reinforces rote learning, discourages questioning, and fosters plagiarism and passive learning attitudes, further inhibiting creative and analytical thinking (Streich, Selke & Saito, 2020; Du, 2020). These issues are deeply rooted in cultural and educational traditions, notably Confucianism, which emphasizes authority and collective thinking over individual inquiry (Cheng & Zhang, 2020; Wang, 2022). Addressing this requires broadening students' cognitive exposure and integrating interdisciplinary approaches to cultivate higher-order skills (Wan, Li, Liu & Li, 2023). However, interdisciplinary education in China remains largely theoretical, with limited practical application, and has yet to effectively enhance students' critical and analytical abilities (Yang et al., 2024).

Educators often lack training and resources to implement interdisciplinary teaching and problem-solving methodologies (Wang, Charoenmuang, & Knobloch, 2020). A student-centered approach that promotes collaboration, communication, and applied learning has proven effective in fostering HOTS (Lu et al., 2021; Tambunan, 2019). However, Chinese colleges have not fully leveraged interdisciplinary teaching





to improve critical thinking, problem-solving, and analytical skills(Qiu, 2020; Yang, Ding & Duan, 2024).

Furthermore, research indicates a gap in Chinese educators' understanding of HOTS, particularly in curriculum design, teaching strategies, and student assessment (Li, 2021; Retnawati et al., 2018). Most studies in China treat interdisciplinary education and HOTS as separate domains, leading to a lack of practical teaching modules to develop students' cognitive and integrative learning abilities(Ma & De, 2020; Min, 2021; Fang, 2023; Jing &Luo, 2023).

Consequently, this study aims to design, development, and evaluate the usability of interdisciplinary teaching modules on enhancing students' higher-order thinking skills within the Chinese educational background, by leveraging insights from international practices in interdisciplinary education, thereby addressing the existing gap in this domain.

1.4 Objective of the Study

According to the needs of Chinese college students and education background, This study will design and develop an interdisciplinary teaching module that integrates science and humanities to expand the breadth of students' knowledge,and evaluate its impact on students' higher-order thinking skills through instructional implementation to provide valuable reference for relative module development research and practice in China. this study based on the design and development research (DDR) approach





(Richey & Klein, 2014), the study consisted of three different phases. The objectives of each consecutive phase were as follows:

A. Need analysis phase

1. To identify the current status and need for teaching interdisciplinary higher-order thinking skills from the perspective of interdisciplinary teachers.

2. To identify the characteristics of interdisciplinary HOTS thinking tendencies among first-year college students.

B. Design and development phase

3. To design and develop the interdisciplinary HOTS module (IHTM) content based on experts consensus.

4. To review the face validity and content validity of the IHTM.

C. Evaluation phase

5. To examine professional title differences in the perceived ease of use (PE), perceived usefulness (PU), attitude (AT), behavioural intention (BI), and self-efficacy (SE) towards IHTM.

6. To determine the usability of IHTM among college interdisciplinary teachers.

Therefore, given the above research objectives, the research questions are as follows:

A. Need analysis phase



Q1: What is the current status and need for teaching interdisciplinary higher-order thinking skills from the perspective of interdisciplinary teachers?

Q2: What are the characteristics of interdisciplinary HOT thinking tendencies among first-year college students?

Design and development phase

Q3: How to design and develop the interdisciplinary HOT module (IHTM) content based on experts consensus?

Q4: How to review the face validity and content validity of the IHTM?

Evaluation phase

Q5: How to examine professional title differences in the perceived ease of use (PE), perceived usefulness (PU), attitude (AT), behavioural intention (BI), and self-efficacy (SE) towards IHTM?

Q6: How is the usability of IHTM among college interdisciplinary teachers?

1.5 Hypothesis

Given that a series of differences analyses were carried out in the needs analysis phase and the evaluation phase of this study, the following hypotheses were formulated:

Hypothesis in Phase 1 (Needs analysis)

H01: There are no significant differences between students' interdisciplinary higher thinking and lower thinking tendency.

H02: There are no significant in students' gender differences in the interdisciplinary HOT tendency.

H03: There are no significant differences in students' major (science and humanities) differences in the interdisciplinary HOTS tendency.

Hypothesis in Phase 3 (Evaluation)

H04: There are no significant differences of teachers' professional title in the perceived ease of use (PE), perceived usefulness (PU), attitude (AT), behavioural intention (BI), and self-efficacy (SE) towards IHTM.

H05: There are no significant differences in the impact of IHTM in terms of HOTS and LOTS

1.6 Conceptual Framework of Research

This study aims at module development and belongs to design-based research, so the method of designing and development research (DDR) is applied. This is due to the suitability of DDR in this study and the fact that this three-stage approach has been well used in similar studies. The research process is divided into three phases: needs analysis, design and development, evaluation. The first phase aims to determine the necessities for this study to solve the question: 1) "What is the current status and need for teaching interdisciplinary higher-order thinking skills from the perspective of interdisciplinary teachers?" 2) "What are the characteristics of interdisciplinary HOTS thinking tendencies among first-year college students?". This will be elaborated upon in subsequent chapters through a comprehensive literature review, to elucidate the current standing of the pertinent fields. As the first phase of the overall study, collecting data from different perspectives can be more effective in ensuring the value



of the research, so here interdisciplinary teachers and first-year colleges students were investigated.

The purpose of the second phase (design and development) is to produce appropriate teaching modules, and since DDR research is continuous, the needs about the modules obtained in the first phase are an important basis for guiding the design of the research in this phase. In addition, the characteristics and details of the instructional modules were identified in this phase through an expert consensus approach, based on the consensus of the experts, the interdisciplinary HOT modules were designed and developed, and after the initial modules were formed, their validity and module information were confirmed, and corrections were completed to be used in the following third phase of the evaluation.



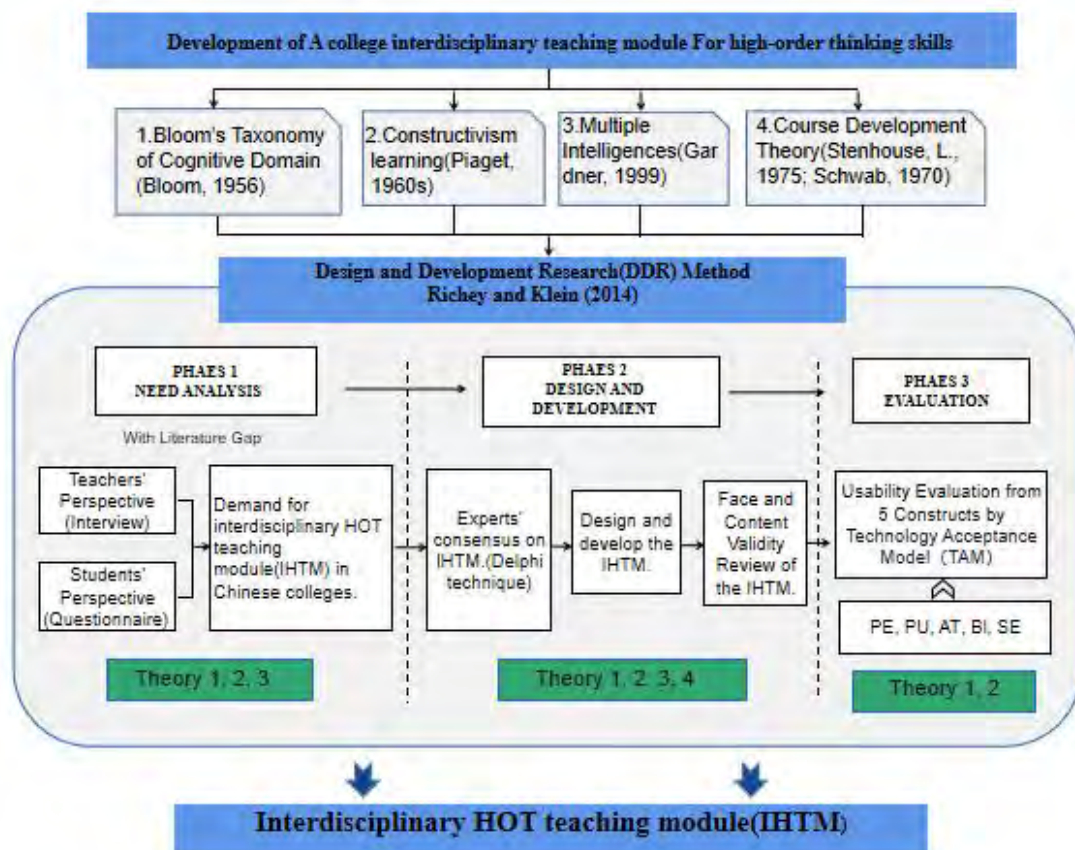
The purpose of the third phase is to evaluate the usability of the pedagogical modules. After forming the teaching modules and verifying validity in the second phase, the usability of the product was validated by a group of users to evaluate whether the teaching module achieved the intended goals. In the case of IHTM, the most relevant users of this pedagogical product are interdisciplinary teachers, and the main purpose of the group of interdisciplinary teachers is to validate the usefulness of the teaching module in terms of the pedagogical goals, i.e., in terms of expanding the breadth of knowledge of the students and improving their higher-order thinking skills, and to evaluate the usability of the module from the users' viewpoints in terms of its ease of use and the practical help it brings to the users, in order to obtain a more comprehensive evaluation of the teaching modules.



Given that DDR is a continuous research process, with each stage of data collection and analysis methodology being independent of each other, the conceptual framework presents the entire process of this study in a three-part format, with the underlying theory being presented. The figure 1.1 below illustrates the sequence and interaction of variables at different stages of the study in the conceptual framework that leads to the conclusion and product.

Figure 1.1

Theoretical Framework



1.7 Operational Definition

Interdisciplinary: The concept of "interdisciplinary" was proposed by the Social Science Research Council in 1926, and is used to refer to Research activities that exceed one scientific scope (Tian & Zhang, 2020). He proposed that interdisciplinary transcends the boundaries of one known discipline and conducts research involving two or more disciplines. With the development and deepening of interdisciplinary research, many scholars have expounded the concept of interdisciplinary from different perspectives, as shown in Table 1.1.

Table 1.1

Description of the definition of interdisciplinary disciplines

Scholar	Description	Concept
OECD, 1972.	The interaction between two or more different disciplines. This role can range from the simple exchange of ideas to the mutual integration of organizational concepts, methodology, epistemology, teaching and research in a fairly large area.	<ol style="list-style-type: none"> 1. Two or more different subjects 2. The interaction between disciplines is reflected in two dimensions: theory and method
G.Begrer, 1972, as cited in Li, 2016.	Interdisciplinary consists of two or two above the door of interaction between different disciplines to form a new discipline, can work through formal and informal two kinds, the form of informal mainly refers to the communication and interaction between the subject and method of formal way refers to the application, integration of professional knowledge and ideas between different disciplines, To achieve interdisciplinary integration in larger fields.	<ol style="list-style-type: none"> 1. Two or more different subjects 2. Mode of operation: formal & informal 3. Knowledge integration



Scholar	Description	Concept
Jantsch, 1970.	Common theorems for a set of related disciplines at a higher level are defined. With the introduction of interdisciplinary links between organizational levels, existing terms, concepts, and principles are harmonized between the two levels, resulting in new scientific concepts, structures, and goals.	<ol style="list-style-type: none"> 1. Related disciplines 2. Higher level coordination
Zhu, 1998.	Interdisciplinary has broad sense and narrow sense. In the broad sense, interdisciplinary generally refers to the mutual connection between science, which is realized through human scientific research activities. In the narrow sense, interdisciplinary means that researchers make use of the internal connection and relationship between various disciplines to achieve interdisciplinary knowledge innovation in certain ways.	<ol style="list-style-type: none"> 1. Classification of broad and narrow sense 2. Knowledge innovation
Li.Z, 2010.	Interdisciplinary is a method of solving complex problems by integrating basic theories, research methods, technical tools and structural designs from different disciplines.	A way to solve a complex problem
Geng , 2011	Interdisciplinary research is a kind of scientific creation activity that breaks the original disciplinary barriers and realizes the leapfrog of different research fields. The research mode can be in the form of individual or team, and solves complex major social problems by integrating multi-disciplinary or professional knowledge, tools, concepts and theories.	<ol style="list-style-type: none"> 1. Cross disciplines 2. Knowledge integration 3. Solve complex social problems
Klein, 2015	interdisciplinary courses are considered those courses that integrate two or more disciplines to facilitate teaching and learning.	Integration of multi-disciplinary teaching and learning in pedagogy.



Scholar	Description	Concept
Liu, 2023	Interdisciplinary is understood as interdisciplinarity and represents the connection between disciplines. The occurrence of interdisciplinarity is due to the existence of interdisciplinarity, so the boundary spans in various forms and interdisciplinary research is often complicated.	1.The disciplines are interconnected 2.complicated and changeable

Although there is no unified definition of the concept of "interdisciplinary" in the academic circle at present, it can be found that interdisciplinary has the following characteristics from the different understandings and interpretations of scholars above:

1.Multi-disciplines: Interdisciplinary research is no longer a single discipline in the past, but to break disciplinary barriers and realize exchanges and cooperation between multiple disciplines (including two or more disciplines).

2.Purpose: by reviewing the source of the emergence and development of interdisciplinary contexts, interdisciplinary, appeared with the development of social productivity and demand in the face of a single discipline couldn't solve the social problem of interdisciplinary contact and cooperation between different disciplines, become the best choice to solve new problems, and the specific purpose for the development of interdisciplinary provides a clear development direction.

3.Knowledge fusion and innovation: interdisciplinary realizes the communication and cooperation between different disciplines. In this process,



knowledge (theories and methods, etc.) between different disciplines is shared and integrated. In the process of sharing and integration, new sparks of thinking are generated, which is conducive to knowledge innovation and promotes the progress of different disciplines.

Teaching module: Teaching module refers to a compact set of teaching guidance for teachers with important information on a specific selected topic. It typically contains clear instructions for users and comes with complementary learning activities to be applied in the teaching and learning process.

In context of this study, the interdisciplinary module is also known as a “teaching module”. Specifically, the module was designed and developed, implemented and finally evaluated in this study. This module consists of an interdisciplinary project-based module that includes both humanities and science subject systems and is implemented under the guidance of a mentor to promote higher-order thinking skills in students.

Higher Order Thinking (HOT): HOT can be conceptualized as a complex mode of thinking that often generates multiple solutions, which involves application of multiple criteria, uncertainty and reflection (Lewis & Smith, 1993). In the context of this study, HOT can be defined as the mode of thinking that basic education students use to reflect the acquired knowledge and apply it to real life situations.

Higher Order Thinking Skills (HOTS): The skills that students use to solve the problem and make judgment about the solution such as application, analysis,



synthesis and evaluation. Higher order thinking skills (HOTS). Twenty-first century skills and HOTS are often used interchangeably and can be defined as constructive learning behaviors such as problem-solving, critical thinking, metacognition, collaborative communication, creativity, digital literacy, and meaning-making (Widana, Parwata & Sukendra, 2018; Elliott, 2020).

For the purposes of this study, HOTS was defined in the same way as the traditional description, based primarily on Bloom's cognitive theory (1956), describing the cognitive levels that students must call upon to complete classroom tasks, one may hear educators refer to rigor, critical thinking, depth of knowledge, complex reasoning, cognitive rigor, higher-order thinking, and cognitive complexity (Donahue, 2021).

Teaching Module: Generally speaking, teaching module or instructional module refers to a compact set of teaching guidance for teachers with important information on a specific selected topic (Tee, 2018). It generally includes instructions and module content for users, and is a complementary component of the curriculum applied to the teaching and learning process, or it can be offered as a separate topic course to promote a particular aspect of students' perceptions and ways of thinking.

In this study, the Interdisciplinary HOT Teaching Module (IHTM) is available for teachers to use in specialized interdisciplinary classrooms and also to apply some disciplinary constructs and thinking to an existing curriculum. to promote curriculum enrichment and expand students' cognition.



Instructional Design: This is a systematic process of developing instructional materials based on learning and instructional theories in order to help learners learn more effectively. It is also an intellectual means to solve instructional problems (Shambaugh & Magliaro, 2001, Rothwell & Kazanas, 2011). Instructional design can also be understood as the whole process from needs analysis, instructional content development, and instructional evaluation. Therefore, in this study, IHTM will start from users' needs analysis and complete the development and evaluation of teaching modules.

College students: Undergraduates, the school that students graduate into after completing high school. In China, there is no clear distinction between the terms college and college, which refer to higher education schools in general, except for a few majors such as medicine and architecture, where the duration is five years, while most majors have a duration of four years

1.8 Study Limitations

Conducted within Shandong Province, this study's collected data offers insights into the regional context to some degree. Nevertheless, given Shandong's prominence as a significant educational and economic hub in China, it is posited that these findings hold considerable relevance for schools and educators across the nation, owing to the uniformity within the Chinese educational framework. However, due to the region, some factors related to humanities, economic conditions, and social concepts could





not be taken into account, and the impact of these factors on the teaching and learning of cross-curricular and higher-order thinking skills needs to be further verified.

This study was conducted in the context and sample of teachers and experts in interdisciplinary fields, college students, the assessors of the module involved 37 teachers and experts, a larger sample size may yield different results. In addition, investigating students' current status in higher-order thinking skills and interdisciplinarity took into account students' gender, however, the influence of other circumstances of students in the implementation of the teaching, such as economic status, upbringing factors, and ethnic customs, and perhaps the variability of the topics under study, were not reflected in this study. Therefore, the later extension of the teaching module with the recruitment of more participants is still of research interest.



The expansive nature of interdisciplinarity inherently limits the content scope of the teaching modules developed in this study. Given the focus of this investigation on developing interdisciplinary teaching modules within Chinese higher education contexts, it becomes imperative to design and cultivate more enriched module content through practical application and subsequent research, thereby establishing a more comprehensive system.

In addition, due to the screening effect of the gaokao system, there are differences in learning and cognition between students at different levels of schooling, which may lead to differences in the effectiveness of the implementation of the IHTM, although the module is designed to take into account the pre-existing knowledge





constructs of the majority of the students, the above limitations are unavoidable, and therefore more pedagogical implementations are proposed to refine the theory and practice of this type in China. practice.

1.9 Significance of Research

This investigation holds substantial significance across both pedagogical practices and theoretical research domains, encompassing areas including interdisciplinary teaching and learning, the enhancement of students' Higher Order Thinking Skills (HOTS), the methodologies employed in the design and development of instructional modules, and the analytical conclusions derived from the status quo survey.



1.9.1 Practical significance of the study

The critical significance of equipping college students with higher-order thinking skills alongside interdisciplinary knowledge is immeasurable. Considering the prevailing deficiencies within the realm of Chinese higher education in these dimensions, this investigation undertakes the design and development of a teaching module targeted at colleges interdisciplinary educators. This module endeavors to enhance higher-order thinking capabilities and to cultivate students' awareness of interdisciplinary thinking traits, thereby rendering it of paramount relevance in the contemporary educational context.





Firstly, teachers can benefit from the findings of the study. On the one hand, Findings gives teachers insights into teaching and learning, and on the other hand, Findings is beneficial to teachers in terms of curriculum development and assessment. So far, many teachers still adopt a teacher-centred, stereotypical model of knowledge transfer, which can only help students with lower order thinking skills, and rote teaching and learning is not desirable, especially in today's time when Students face in real world are complex, unstructured, complicated, new and require more thinking (Pratama & Retnawati, 2018). Therefore more focus on the development of integrated and holistic skills is needed to cope up with the impact and challenges of technological development on education.

Consequently, in order to augment students' capacity for interdisciplinary engagement and elevate their higher-order cognitive processes, the findings supports the adoption of a more open and adaptable pedagogical framework, wherein students are envisaged as the principal agents, aiming to rectify the conventional, didactic, and memorization-centric pedagogical approaches that predominate in Chinese educational systems. This paradigm thereby furnishes students with enhanced opportunities for critical engagement and reflective thinking. Furthermore, collaborative endeavors have been empirically shown to galvanize student initiative, as it necessitates the confluence of students from diverse disciplines collaborating in compact teams directed towards the resolution of complex problems, which can substantially amplify the efficacy of attaining pedagogical objectives.

On the other hand, the findings delineate a comprehensive design development process for teaching modules, and design-based research emerges as an efficacious





approach for product development within the realm of pedagogy. Moreover, the DDR methodology (Richey & Klein, 2014) was substantiated by this study to be applicable for the related research in the formulation of analogous interdisciplinary and higher-order cognitive skills teaching modules, which furnishes interdisciplinary educators with a useful reference framework.

Secondly, for policy makers, the current situation described in the study is noteworthy. Findings from the study validate the current situation of students' interdisciplinary and higher-order thinking skills, which will help policy makers to plan the direction of college education in order to give more attention to students' all-round development. This study presents an approach from the perspective of module development that could be useful for policy makers to organise more module design activities in Shandong Province and to formulate guidelines for student development programmes that promote higher-order thinking skills and interdisciplinary knowledge, which could lead to positive changes in higher education.

1.9.2 Theoretical significance of the study

The pedagogical module devised in this investigation is aimed at augmenting the instruction of advanced cognitive skills and broadening interdisciplinary knowledge via integrated content, thereby fulfilling pedagogical objectives. The findings present the crafted pedagogical module and assess its usability. The module includes an introduction, outlining its distinctive features alongside suggested teaching strategies,





collectively forming a cohesive system. This framework not only promotes the enhancement of higher-order thinking abilities but also facilitates the expansion of interdisciplinary understanding, thereby aligning with the overarching educational goals.

The elements within the system contain characteristics of interdisciplinary higher-order thinking skills instruction, typical teaching and learning processes, and this framework can serve as a useful reference and guide for teachers to provide information about interdisciplinary and higher-order thinking skills instruction. Although limited module content was developed in this study, the framework has general reference value for curriculum implementation in similar categories, and teachers can use it as a basis for designing and implementing richer instructional content.



1.10 Summary of Chapter

This chapter delineates the research background, underscores the necessity, and articulates the significance of this investigation, elucidating how this study plays a pivotal role in cultivating students' knowledge breadth, enhancing thinking capabilities, and expanding cognitive dimensions. In light of the identified challenges, the research objectives and questions are systematically articulated, and the contribution of this study within the pertinent fields in China is expounded upon.





In addition, the scope and limitations of this study is presented in this chapter, and defines the terms used in the study. At the end of this chapter, the terminology used in the research process is defined. The literature and theories supporting this study will be discussed in the next chapter.

