A DEVELOPMENT OF THE PROJECT-BASED LEARNING MODEL FOR ENHANCING INNOVATIVE THINKING OF UNDERGRADUATE STUDENTS

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A DEVELOPMENT OF THE PROJECT-BASED LEARNING MODEL FOR ENHANCING INNOVATIVE THINKING OF UNDERGRADUATE STUDENTS

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Innovative thinking is a crucial workforce in the 21st century and based on the background of undergraduate education in China. The aims of this study are as follows: (1) to study the definition and components of innovative thinking of undergraduate students; (2) to develop a Project-Based Learning model for enhancing innovative thinking of undergraduate students; and (3) to evaluate the effectiveness of the Project-Based Learning model for enhancing innovative thinking among undergraduate students. The samples were undergraduate students in Yunnan Arts University. The research instruments were semi-structured interview questionnaires, innovative thinking questionnaires (reliability of .087), and the Project-Based Learning model. The samples consisted of 50 undergraduate students that were randomized equally to the experimental group and the control group. The experimental group (n=25) received the Project-Based Learning model for enhancing innovative thinking, but the control group was not. The research results were as follows: (1) the innovative thinking of undergraduate students consisted of five components; (2) the Project-Based Learning model was developed that composed of five steps and the Project-Based Learning model consisted of 10 lesson plans; and (3) the Project-Based Learning model was effective in promoting innovative thinking among undergraduate students, and the experimental group continued to show improvement in the follow-up period.

Keyword : Innovative thinking, Project-Based learning model, Undergraduate student enhancment

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CHAPTER 1
INTRODUCTION

1.1 Statement of the Problem

The economic and social development of the contemporary world increasingly relies on innovation in theory, system, science and technology, as well as culture. Moreover, in the context of international competition, the capacity for innovation has become paramount in gaining a competitive advantage. To face the challenge, in the field of education, the American Association of Colleges for Teacher Education states that higher-order cognitive abilities and skills are necessary for survival in the new society. Especially, innovative thinking considered essential for the 21st-century workforce and considered valuable characteristics of human cognition (Barak and Usher 2019). Only innovative thinking can solve problems and open up a new paths (Gao 2021). Today, education is faced with the need to teach a systematic approach to innovative thinking and problem solving (Barak and Goffer 2002). Numerous recent studies have emphasized the need for enhanced emphasis on critical thinking skills in education. Universities are currently exploring effective strategies to incorporate this aspect into their curriculum, while simultaneously ensuring that graduates meet the required disciplinary knowledge standards (Davis and Amelink 2016). This has led to an increase in the availability of creative courses within higher education institutions, including extensive entrepreneurship programs and advanced modules designed to foster students' ability to think innovatively (Barak and Usher 2019). These approaches develop students' ability to adapt to changing work environments, new roles, in a time of swift transformation and interconnectedness, emerging sectors are being established.

Innovative thinking is the cornerstone of college students worldwide, serving as a vital asset for nurturing their own ingenuity and an essential attribute required in today's digital age. Innovative thinking is perceived as the mental procedure that results in the implementation of fresh or considerably enhanced concepts (Barak, Watted et al. 2020); (Cropley 2015). In addition, According to Hart (1996), the process of innovative thinking involves the generation of fresh ideas in order to address concerns related to

the educational progress of children(Hart 1996). Innovative thinking refers to an individual's capacity to generate ideas and develop novel knowledge, thereby expanding their self-awareness and personal growth(IGNATOVA, OVCHARENKO et al. 2019). Therefore, improving the innovative thinking of college students is a worthwhile research topic and a concern for the researchers. In this current study, the researcher will focus on the definition based on Morad and his colleges' study.

According to the literature review, innovative thinking consists of several components. For example, in Dyer's research, innovative thinking consisted of four components. These activities involved observation, exploration, inquiry, and collaborative idea generation(Dyer, Gregersen et al. 2019). In Raviv's research, he identified four constituent components of innovative thinking as: 1) problem solving 2) big picture 3) personal 4) social skills(Raviv 2008). Furthermore, in Morad's research, there were five components of innovative thinking.

In new era, innovative thinking is an indispensable core competency in students' learning and life (Gao 2021). Education should prioritize fostering a mindset of innovative thinking as its main objective. Innovative thinking is closely related to possessing a growth mindset that values learning and advancement, creativity and the ability to translate and implement it into practice, the ability to effectively solve problems based on real or virtual environments, and the competence to question assumptions, evaluate evidence, and make decisions. Zupan consider "Relevant skills for young individuals include the ability to think innovatively and effectively, as well as possessing an entrepreneurial mindset that can be applied universally (Zupan, Cankar et al. 2018). Individuals who possess strong innovative thinking skills are capable of actively acquiring knowledge and effectively organizing information through the establishment of internal cognitive associations. Good innovative thinking stimulates areas of interest, curiosity, and collaborative qualities (Franco and DeLuca 2019).

Innovative thinking is so important for undergraduate students, and the current situation of innovative thinking of students in Chinese universities is not optimistic. This problem is especially prominent among students majoring in design-related disciplines

in Chinese colleges and universities. In this study, the researcher is a teacher who has been teaching students majoring in visual communication design at Yunnan Art University, in China. According to the researcher's observation, most of these students lack innovative thinking. They always copy their classmates' projects and have the same ideas. They have difficulty creating new things. They did not know how to develop and implement their products. They are more focused on traditional design skills or techniques. Among these students, there is cognitive misconception and a lack of emphasis on learning about innovative thinking, which makes it difficult to have the ability to identify problematic needs and generate new ideas.

Weak innovative thinking will bring great difficulties to college students' professionalism in their future work, which will lead to poor professional quality, low competitiveness, and easy substitution. With this comes the result of not having the ability to accurately define problem-solving, and the results of the work become outdated or irrelevant, leading to a loss of competitiveness in the marketplace. Self-perceived value declines, which in turn becomes disconnected from the needs and expectations of users or customers, constraining one's ability to remain relevant and competitive in the field.

The relevant documents of the national innovation-driven development strategy outline emphasize the promotion of educational innovation, transformation in talent cultivation approaches, and integration of scientific spirit, innovative thinking, creativity, and social responsibility into every aspect of education. With social service capacity, these initiatives will effectively promote the skills, knowledge, and mindset to participate in social service activities to meet the needs of the community (Xing, Xing et al. 2021). Therefore, universities should not only focus on professional education, but also teach students how to cultivate cognitive skills in innovative thinking and practical abilities and bring education closer to real needs and future trends.

Governments across the globe recognize universities as crucial hubs for generating fresh knowledge and fostering innovative ideas. They also acknowledge their role in producing skilled individuals with credible qualifications, driving innovation,

attracting international talent and business investments to a particular region, promoting social justice and mobility, and contributing to the overall social and cultural vibrancy(Boulton and Lucas 2011). Moreover, as college students face increasing pressures, it is imperative that they make the transition from school to the workplace effectively. School-to-work programs must therefore be tailored to equip college students with the necessary skills and knowledge they need to succeed in today's job market (Rogers, Creed et al. 2000). Therefore, the enhancement of innovative thinking has a very important location in the future study, employment, and life of undergraduate students.

According to the literature review, there are many ways and strategies to promote innovative thinking to college students such as using collaborative learning, active learning, problem-solving practicing, Project-Based Learning, and training courses. However, in this study, the researcher will use project-based learning as the approach to promote innovative thinking for college students majoring in visual communication design. This research aims to investigate strategies for the development of a Project-Based Learning framework that can effectively foster students' capacity for innovative thinking.

The use of Project-Based Learning as a pedagogical approach to enhance innovative thinking in higher education, the potential of Project-Based Learning in actively involving students in real-life and open-ended challenges is emphasized, as it has been demonstrated to improve higher-order cognitive abilities, motivation, and engagement(Barak and Yuan 2021). Creativity, critical thinking abilities, communication skills, collaborative skills, and self-directed inquiries and lifelong learning skills can all be fostered through the implementation of Project-Based Learning (Nelson 2017). Project-Based Learning is one of the higher-order thinking skills used to improve the process's quality and learning outcomes (Simbolon and Koeswanti 2020). Project-Based Learning is a Project-Based teaching mode with life experience as orientation and "real problems" as the core. It strives to incorporate students into a purposeful process of accomplishing tasks in order to attain educational objectives(Liu and Zhao 2021). In this

current study, the researcher will focus on the definition based on Bark & Yuan, (2021), In higher education, Project-Based Learning is an open-ended inquiry-based approach to teaching and learning. It enables students to have the observational skills to identify problems based on the real-world problems and tasks provided, the creativity to stimulate new ideas, the linking ability to use innovative tools for continuous inquiry, the cognitive ability to realize their self-worth and the social added value of their products through the formation of effective product development with the ability to iterate and implement the product results into a product(Barak and Yuan 2021).

According to the literature review, Project-Based Learning consists of several steps. For example, in Larmer & Morgentaler's research, proposing generic Buck Institute's Project-Based Learning models consisted of seven steps. These were design and planning, aligning to standards, building the culture, managing activities, scaffolding student learning, assessing student learning, engaging, and coaching (Larmer, Mergendoller et al. 2015). The six steps of project based learning: 1) Defining the purpose 2) Researching the topic 3) Designing the project 4) Beginning the project 5) Resolving problems 6) Completing the project(Blumenfeld, Soloway et al. 1991). The application of the five-stage Project-Based Learning process in higher education can be beneficial due to its organized structure that is based on prior research. It consists mainly of: 1) Individual ideation 2) Team ideation 3) Team implementation 4) Peer assessment 5) Pitch and bid (Barak and Yuan 2021). In Liu (2021) research, he identified five steps of project-based learning: 1) Analysis phase 2) operation management 3) design phase 4) presentation 5) appraisal and reflection (Liu and Zhao 2021).

Studies conducted by academics have shown that the adoption of a Project-Based Learning methodology led to notable improvements in educational achievements. These improvements encompassed learners' perception of social responsibility within the university, their competence in addressing intricate and ambiguous structural issues, their ability to apply professional knowledge effectively, as well as their skills in team building and communication. Overall, this initiative had a positive influence on

students enrolled at the university(Ting, Cheng et al. 2021). Employing project-based learning as an instructional approach to cultivate innovative thinking in higher education underscores the capacity of project-based learning to actively involve students in authentic and open-ended problems, resulting in enhanced analytical reasoning abilities, drive, and involvement (Barak and Yuan 2021). The shining point of the Project-Based Learning framework was observed to be an effective teaching methodology. This approach not only guarantees a well-rounded development, collaboration, and long-term viability but also enhances critical thinking abilities, learning aptitude, interpersonal skills, self-confidence, and effective communication. Additionally, it is speculated that Project-Based Learning equips students with lifelong learning capabilities to tackle emerging challenges in professional or personal life, envision future adaptations, secure patents, and transform prototypes into marketable products (Patange, Bewoor et al. 2019). These studies fully demonstrate that Project-Based Learning has significant advantages in innovative thinking due to its features.

The theoretical underpinnings of the learning model developed in this study include constructivism learning theory and innovation theory. Larmer refers to Project Learning is a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks (Markham, Larmer et al. 2003). Barak believes that Project-Based Learning is a highly organized teaching method that enables active participation in the genuine exploration of real-world and open-ended challenges through collaborative teamwork (Barak and Dori 2005). It is a viable approach to student-centered teaching and learning (Žerovnik and Nančovska Šerbec 2021). Constructivism learning theory provides a supportive framework for fostering the cognitive and experiential processes that underlie innovative thinking. Through encouraging active engagement, knowledge construction, collaboration, and reflection, the Constructivist learning methods can help individuals develop the skills and mindset necessary for innovative thinking. Therefore, in this study, the researcher will develop

the Project-Based Learning model to enhance the innovative thinking for undergraduate students in China.

1.2 Research Questions

1) What are the definition and component of innovative thinking of undergraduate students?

2) How to develop a learning model for enhancing innovative thinking through Project-Based Learning?

3) How To evaluate the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students?

1.3 Objectives of the Research

1) To study the definition, and component of innovative thinking of undergraduate students.

2) To develop the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

3) To evaluate the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

1.4 Significance of the Research

1) Through research, we can gain a deeper understanding of the innovative thinking level of undergraduate students.

2) Further exploring the feasibility and applicability of the Project-Based Learning model to enhance undergraduate students' innovative thinking is conducive to carrying out teaching reform.

3) Beneficial to undergraduate teachers can use Project-Based Learning model to develop teaching strategies, smooth teaching and improve students' learning efficiency.

1.5 Scope of the Research

Phase 1: Studying the definition, and component of innovative thinking of undergraduate students. Through literature review and interview 5 experts. The researcher synthesized to get the definition and components of undergraduate students innovative thinking. secondly, to investigate the level of undergraduate students innovative thinking through the researcher's questionnaire on undergraduate students innovative thinking. Population: According to the <2022-2023 Yunnan Provincial Education Development Statistics Bulletin> released by the Yunnan Provincial Department of Education in April 2023, there are now 1,616,600 undergraduate students in Yunnan Province. Sample: the researcher used multi-stage random sampling method, one university in Yunnan Arts university were extracted from Kunming City, using 100 students majoring in art design to completing the questionnaire.

Phase 2: Developing a Project-Based Learning model for enhancing undergraduate students' innovative thinking. The model design was carried out through literature review, interview 5 experts along with the characteristics of the undergraduate students' components and undergraduate students innovative thinking level in the first phase. After that, the model was adjusted through the suggestions given by 3 model evaluation experts. And try-out with 10 undergraduate students in the same major. Finally, got the final learning model**.**

Phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students. Population: Yunnan Arts University undergraduate students, the students major is art design (n=100 students). Sample: This sample population was used to evaluate the use these models to improve innovative thinking of undergraduate students. This sample group had 50 students, who were selected through random sampling, and who volunteered to participate in the trial. They were divided into experimental group and control group with 25 students in each group.

1.6 Variables

Independent variable

Project-Based Learning Model

Dependent variable

Innovative Thinking

1.7 Definition of Terms

1.7.1 Innovative Thinking

Based on Constructivism Learning Theory and Innovation Theory and semi-structured expert interviews got the definition of innovative thinking and the components. In my research, innovative thinking define is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value. It is composed of the following five components:

1) Cognitive competency to identify needs. Refers to the ability to effectively identify or articulate a requirement or an issue. This pertains to the identification of the necessity, problem, or objective. It implies that someone possesses the mental capacity and skills necessary to understand and clearly describe what is lacking or what is wrong in a given situation. In various contexts, such as problem-solving, decision-making, or innovation, being able to define a need or a problem accurately is a crucial skill.

2) Cognitive competency to generate new ideas. Refers to an individual's ability to create fresh, innovative, or modified concepts and thoughts. This cognitive competency is often associated with creativity and problem-solving. It involves the capacity to think creatively, make connections between seemingly unrelated concepts, and explore novel solutions to challenges.

3) Cognitive competency to change ideas to formulate outcomes. Refers to a person's ability to link newly generated or modified ideas to actual generation. It suggests that someone has the mental skills and capabilities needed to not only come

up with innovative concepts but also to implement and realize those concepts effectively. This competency involves the capacity to translate abstract or conceptual ideas into tangible actions, plans, or products. It includes the ability to strategics, plan, organize resources, and execute tasks in a way that aligns with the fresh concepts or modified notions.

4) Cognitive competency to implement results. Refers to the ability to successfully iterate and apply new or improved results from experiments. The subject of analysis encompasses the global sphere, societal structures, economic markets, organizational entities, collective bodies or individual units. This pertains to the extent and uniqueness of its influence on individuals.

5) Cognitive competency to realize added value. Refers to a person's ability to accept and utilize new or improved results or solutions that provide additional benefits or advantages. It means that an individual can recognize the value of new ideas or improvements, adapt to them, and use their added benefits to achieve better results or outcomes. Novel, beneficial, and accomplished products, concepts, theories, and/or processes receive acknowledgment and support both within their respective domains as well as beyond. For example, obtaining a patent for an individual invention.

1.7.2 Project-Based Learning model for enhancing innovative thinking of undergraduate students

Project-Based Learning model based on and integrated the research of (Barak and Yuan 2021)and (Larmer and Mergendoller 2010) on Project-Based Learning theory. Project-Based Learning model is an open-ended inquiry-based approach to teaching and learning. It enables students to have the observational skills to identify problems based on the real-world problems and tasks provided, the creativity to stimulate new ideas, the linking ability to use innovative tools for continuous inquiry, the cognitive ability to realize their self-worth and the social added value of their products through the formation of effective product development with the ability to iterate and implement the product results into a product. It is composed of the following five steps:

1) Identification of need and problem. Teachers gather data and evidence to identify current needs for products by guiding students to actively mobilize recognition and observation ability, combined with life experiences. And emphasizes the importance of choosing real-world problems for a more authentic learning experience and Cleary describes how to identify problems effectively.

2) Generation of new ideas. This phase is the process of linking. Teachers in this phase build links with seemingly unrelated concepts by guiding individuals through creative activities based on life experiences and environments, data, and evidence, and incorporating diverse idea-generation techniques. Students can combine experiences and subject matter knowledge to facilitate personal conceptualization of observational problems and the capacity to produce a range of concepts and create links between unrelated concepts. Subsequently forming and facilitating team ideation, actively mobilizing the creativity of the team to reach the stage of refining and combining individual ideas of co-creating links of ideas. Strategies such as storytelling and SCAMPER help further enable individual creativity. Combined with the use of field research tools, it mainly includes activities such as gathering information/facts, collecting data from customers and users, perception lists, visual charts, information analysis, classification, etc.

3) Development of outcome through new Idea. At this stage is a process of realization of iterative creative thinking. Teachers provide resources and guidance to help students develop and refine their ideas into practical outcomes based on their creative outputs. Strategies such as storytelling and SCAMPER help further enable individual creativity. Combined with the use of field research tools, it mainly includes activities such as gathering information/facts, collecting data from customers and users, perception lists, visual charts, information analysis, classification, etc.

4) Implementation of new outcome. implementation showcase selected ideas and give them a physical form to express the idea in a presentation. Students present their projects in a commercially attractive manner by participating in an activity. This activity can take place in a classroom, outdoor public space, or other platform (e.g.,

exhibition hall). Team presentations (highlighting the innovative aspects of the product outcome) and convincing the audience, including industry professionals, mentors, and possibly other stakeholders, of the commercial appeal (feasibility of implementing the new improvement). Learning effectiveness assessment, where the instructor organizes the students to provide constructive feedback to their peers during the product demonstration phase and to improve their product based on the feedback received. Of course, this feedback follows standards and guidelines and focuses primarily on evaluating the feasibility of a peer's performance, skills, knowledge, or product.

5) Adoption of new outcome. New outcome adoption and the additional benefits or advantages it brings. For example, the cognitive ability to know how to use new outcome to gain more economic recognition and social value from society, and to be able to recognize the communication channels through which the value of a new idea or new improvement can be additionally benefited. And acquiring personal intellectual property rights and gaining socio-economic rewards.

1.8 Research Hypotheses

1.8.1 undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than before beginning the experiment.

1.8.2 undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than those in the control group.

1.9 Conceptual Framework

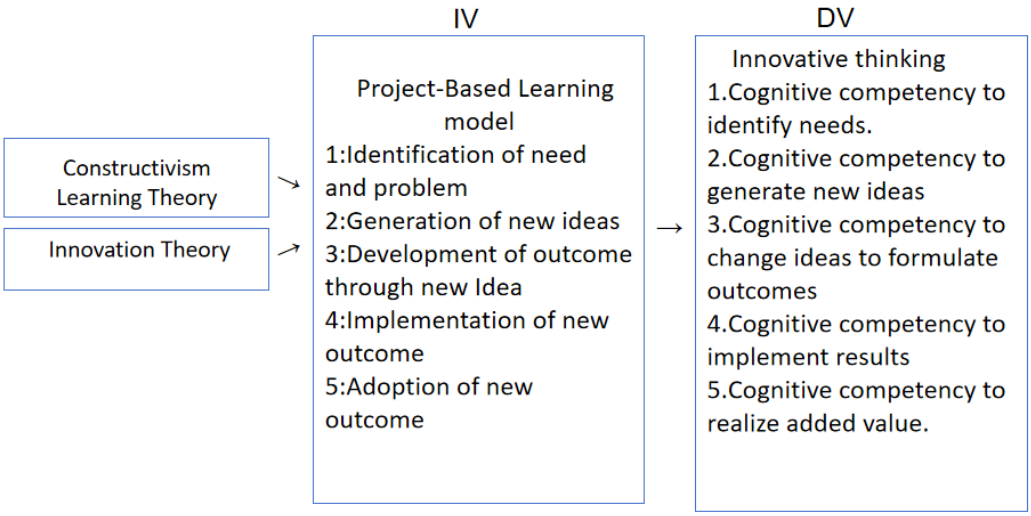

FIGURE 1 Conceptual framework

CHAPTER 2
LITERATURE REVIEW

2.1 Innovative Thinking

2.1.1 Definition of Innovative Thinking

Maley consider fostering innovative thinking, it is essential to cultivate creativity as a fundamental requirement. Creativity encompasses fundamental concepts such as generating novel ideas, expressing thoughts in unique ways, discovering new associations, and eliciting delightful surprises (Maley 2003). Creativity refers to the capacity for innovative thinking in order to solve problems and generate unique and valuable ideas(Torrance 1966). This ability is influenced by a combination of psychological and environmental factors. The emergence of creativity is a result of the interplay between five psychological factors: intelligence, knowledge, cognitive approach, individual traits, and drive. These factors are further divided into three key elements: motivation for work, expertise in specific fields, and associated abilities for creativity(Amabile 2011). It is becoming more and more evident that the possession of creative abilities is crucial in the modern era and should be included in educational curricula from an early age(Vygotsky 2004). Creativity is frequently regarded as a mental and affective endeavor (Fuchs and Fuchs 2007).It that can be enhanced by a discovery-based learning process that enables learners to manipulate their environment and foster innovative concepts (Munro 2011).

According to Hilton and Pellegrino (Hilton and Pellegrino 2012), innovation is a crucial competency in contemporary society, encompassing cognitive aptitude, instructional approaches, and mental procedures. The term innovation has its roots in the ancient cultures of Greece and Rome, and was acknowledged even earlier in Eastern societies (Saxena 1993, Zambon 2008). However, the academic concept of "innovation" in his seminal book, he give innovation as the alteration of production processes and the restructuring of preexisting assets (Schumpeter 2008). Similarly, innovation as the transformative process that converts an invention into a concrete product or system(Westwood and Sekine 1988). Roberts(1988) defines It is a

combination of invention and dissemination - invention means the generation of new ideas, and dissemination is the successful implementation of those ideas through application, transfer, and evaluation(Roberts 1988). Romer think Innovation serves as a catalyst for the development and implementation of novel designs or ideas(Romer 2009). Furthermore, problem-solving has also been identified as a catalyst for innovation: an intricate activity that progresses from conceptualizing novel ideas to solving problems and ultimately utilizing them for economic or social value (Myers and Marquis 1969). Encompassing all stages from idea conception to practical utilization (Kanevsky and Keighley 2003). Morad proposes a multidisciplinary definition of innovation: Innovation involves identifying needs or problems, generating new or modified ideas accordingly, developing outcomes aligned with these ideas while considering recipients' requirements; finally adopting improved outcomes with added value(Morad, Ragonis et al. 2021). Based on the a forementioned analysis, it can be concluded that creativity is driven by the pursuit of "newness," "unique creation," and the "unprecedented," while innovation focuses on commercial aspects such as "viability," "applicability," "efficiency," and "decision-making. So as a product will be both the result of creativity and the foundation for generating market worth lies in fostering inventive thought(Zhan, Shen et al. 2022).

The capacity to engage in innovative thinking and produce fresh concepts plays a pivotal role in acquiring knowledge and thriving in the contemporary global landscape characterized by rapid transformations (Tang and Werner 2017). With innovative thinking, you have a flexible mind and endless creativity (Fu 2019). Innovative thinking has long been defined by different experts from different perspectives, and the literature survey conducted synthesized the following main definitions. Innovative thinking involves actively seeking multiple perspectives, considering facts from various sources, exploring alternative possibilities, and acknowledging the potential for error even in our most cherished beliefs. When referring to innovative thinking in the field of education(Dewey 1933). Educational innovation as the utilization or introduction of novel educational resources, instructional methods employed by teachers, and organizational

frameworks with the aim of enhancing both the quality and efficiency of education (Foray and Raffo 2012). Innovation as the utilization or introduction of novel educational resources, instructional methods employed by teachers, and organizational structures with the aim of enhancing the quality and efficiency of educational concepts into fresh teaching approaches and initiatives(Foray and Raffo 2012).

Hart (1996)	innovative thinking is a way of generating new ideas about what might be done in response to concerns about childrens learning
Aleinikov (2013)	Definition describes innovative thinking as a process
Li(1987)	Innovative thinking is the thinking ability during the innovation process
Lu (2013)	It is a thinking process of discovering new things, creating new methods, and solving new problems on the basis of personal experiences
Xu & Chen(2010)	Innovative thinking is the thinking ability during the innovation process
Anderson et al., 2014	It stimulates the realization and accomplishment of new ideas
IGNATOVA (2019)	the ability of a person to generate ideas, create innovative knowledge, i.e. to open their sense on the basis of self-cognition and self-perfection.
Dilekli (2019)	Innovative thinking is an essential skill during problem solving and the process of judging oneself.
Sokolov(2020)	Innovative thinking is aimed at seeking, discovering, creating something new.
Morad(2021)	the cognitive competency to define a need or a problem, generate new or changed ideas, develop an outcome in accordance with new or changed ideas, implement a new or improved outcome for the addressee, and adopt a new or improved outcome with added value.
Orakcı (2020)	Innovative thinking is a significant feature for careful reflection because any kind of questioning that is deliberately centered on incomplete evidence only becomes less important itself.

FIGURE 2 Different experts' definitions of innovative thinking

This definition does not mention the implementation phase and focuses only on the initial stage of generating ideas. Innovative thinking is seen as the cognitive process that results in the utilization of novel or considerably enhanced concepts (Barak, Watted et al. 2020); (Cropley 2015). According to a study it was found that there are four recurring behaviors that are highly effective in acquiring innovative ideas:

observation, exploration, inquiry, and networking for idea generation(Dyer, Gregersen et al. 2019). Enhancing the ability to think innovatively is believed to be a trainable skill that can be developed and amplified(Barak, Watted et al. 2020); (Cropley 2015). Consequently, in recent times, educational initiatives aimed at enhancing students' capacity for innovation through the provision of a diverse set of skills that align with the demands of a contemporary economy (Dyer, Gregersen et al. 2019). In the realm of science, the concept of innovative thinking pertains to a cognitive process that involves uncovering novel concepts, devising fresh approaches, and resolving unfamiliar challenges based on individual encounters(Lu, Hu et al. 2013). When referring to innovative thinking in the context of education.

Chinese scholars have also put forward a corresponding of innovative thinking. It refers to the ability to participate in innovation(Xu and Chen 2010). However, this definition lacks a detailed breakdown of the part of innovative thinking. Innovative thinking as the ability used in the process of innovation (Li 1987).

Conclusion: According to this study, innovative thinking definition is the cognitive competency, specifically is undergraduate students to think in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value.

2.1.2 Theory Foundation of Innovative Thinking

2.1.2.1 Constructivism learning Theory

According to the constructivist perspective, students engage in independent and active construction of their cognitive understanding through interactive experiences with the real world (Ertmer and Newby 1993). Knowledge is formed as individuals actively structure their learning encounters based on their own interpretation of reality. Although this process is subjective and personal, it is significantly influenced by social interactions (Ertmer and Newby 1993) (Atkins 1993). Learners perceive the world around them and develop rules and thought patterns that reflect their experiences, enabling them to generate new insights in thinking. Diverse approaches, including collaborative learning, experiential problem-solving, and research, are

incorporated into these educational experiences(Sasson, Malkinson et al. 2022). These methods foster active learning by involving the teacher as a mediator between the learner and the tools used for knowledge acquisition (Nagowah and Nagowah 2009).

As stated by the constructivist learning theory is a pedagogical approach that fosters the logical and conceptual growth of students(Driscoll 1994). The fundamental idea behind this theory is that students' education is influenced by their experiences and interactions with the surrounding environment. In line with constructivism, individuals generate knowledge and derive meaning from their personal encounters. "Accommodation and assimilation, two pivotal concepts in this theory, play a vital role in the development of new knowledge among individuals. Assimilation entails the integration of novel experiences with existing ones, leading to the emergence of fresh perspectives, reassessment of previous misconceptions, and evaluation of what ultimately holds significance, resulting in a transformation in perceptions. On the other hand, accommodation refers to reframing one's mental framework to incorporate new experiences into pre-existing cognitive capacities. Individuals develop a particular understanding of how the world operates; however, when confronted with situations that do not align with their existing context, they must accommodate these discrepancies by adjusting their expectations accordingly (Bada and Olusegun 2015).

Constructivism learning theory provides a supportive framework for fostering the cognitive and experiential processes that underlie innovative thinking. By encouraging active engagement, knowledge construction, problem-solving, collaboration, and reflection, constructivist learning theory can help individuals develop the skills and mindset necessary for innovative thinking and problem-solving.

To summarize, knowledge is constantly changing with the deep development of individual cognitive activities, and it is the process of constructing learners' self-meaning. The process of human self-meaning construction is active. Learning as a social activity, individual learners need to communicate and cooperate with others, such as teachers, friends, family, etc., to form their own unique insights in the collision of thinking, a process that contributes to the formation of innovative thinking.

2.1.1.2 Innovation Theory

Innovation theory does not have its roots in a singular discipline or school of thought. A significant outcome of the evolution in innovation theory has been the realization that fostering innovation should not solely rely on technological research and development. It also involves recognizing the importance of policy interventions to enhance the institutional framework and create opportunities for interactions, thereby providing better incentives for innovation(Greenacre, Gross et al. 2012).

The theory of innovation has its origins in Latin and encompasses the three meanings of renewal, creating something new, and change. American economist Schumpeter, Joseph Schumpeter Pre-1950 analyzed for the first time the process of innovation and established the three stages of invention, innovation, and diffusion(Schumpeter 2008). 1950s and 1960s: proposed demand-pull theory, suggesting that the primary driver of inventive activity lies in the demand for products and services rather than advancements in knowledge. In this perspective, economic factors play a crucial role in determining both the pace and direction of innovation (Greenacre, Gross et al. 2012). And subsequently developed in different ways at different times. 1970s to 1990s innovation theory has undergone further development and refinement through three distinct approaches that seek to explain technological change: induced innovation, evolutionary perspectives, and path-dependent models (Ruttan 2000). 1970s to 1990s innovation theory has undergone further development and refinement through three distinct approaches that seek to explain technological change: induced innovation, evolutionary perspectives, and path-dependent models 1980s to 2000s The latter part of the 20th century witnessed an escalating scholarly interest in transforming the traditional linear model of innovation into a more accurate representation that acknowledges the intricate and interconnected nature of the innovation process(Ruttan 2000). It has evolved from the 1990s to the present day into a dynamic, non-linear, integrated process involving a variety of interacting entities. Emphasis is placed on the exchange of knowledge between entities and their expectations of future technological advances, market trends, and policy developments.

In the field of education, "Investigating the concept of innovation theory sheds light on the reasons behind the limited success of classroom change initiatives, which often fall short of their intended outcomes (Wall 1996). In a research conducted an inclusive conceptual model was developed, combining innovation and cognitive creativity. This comprehensive framework aims to foster the ability for innovative thinking among individuals across different age ranges, providing guidance for its practical application (Morad, Ragonis et al. 2021). Morad points out the relationship between innovation and innovative thinking that innovation is the outcome or result of the cognitive process of innovative thinking

To summarize, Innovative thinking and innovation theory are closely intertwined in the innovation process. Innovative thinking fuels the produce of new ideas and creative solutions, while innovation theory provides the conceptual framework and understanding needed to explain, guide, and improve innovation efforts. So, innovation theory and innovative thinking are one of mutual influence and dependency.

2.1.3 Components of Innovative Thinking

From a constructivism learning perspective, this study included five innovative thinking components. Innovative thinking components are: the cognitive competency, students can to define a need or a problem, and they can to generate new or changed ideas, can to develop an outcome by new or changed ideas, can implement a new or improved outcome, can to adopt a new or improved outcome with added value (Morad, Ragonis et al. 2021).

An explanation of the first part components, this pertains to the identification of the necessity, issue, or objective. Refers to the ability to effectively identify or articulate a requirement or an issue. It implies that someone possesses the mental capacity and skills necessary to understand and clearly describe what is lacking or what is wrong in a given situation. In various contexts, such as problem-solving, decision-making, or innovation, being able to define a need or a problem accurately is a crucial skill. If you find that you cannot answer questions, or that you cannot understand the

material discussed, you must then determine what needs to be done to ensure that you meet the cognitive goal of understanding the text (Livingston 2003).

An explanation of the second part components, the act of creating and merging concepts to connect current endeavors with prior encounters in order to address forthcoming challenges (Baskaran and Mehta 2016). Constructivist learning theory is a philosophy that promotes students' logical and conceptual development(Driscoll 1994). The fundamental principle of this theory is the significance of experiences or interactions with the surrounding environment in shaping student education. According to constructivism, individuals generate knowledge and meaning based on their experiences. Two crucial concepts within this theory are assimilation and accommodation, which facilitate the construction of new knowledge for an individual. Assimilation involves integrating new experiences into existing ones, leading to novel perspectives, reevaluation of previous misunderstandings, and prioritization of important aspects that ultimately alter perceptions. Accommodation entails reframing the world and new encounters into one's mental capacity already established by pre-existing beliefs about how things operate. When events do not align with these expectations, individuals must accommodate by adjusting their outlooks to match reality (Bada and Olusegun 2015).

An explanation of the third part components refers to an individual's ability to take freshly generated or modified ideas and turn them into practical results or solutions. It suggests that someone has the mental skills and capabilities needed to not only come up with innovative concepts but also to implement and realize those concepts effectively. This competency involves the capacity to translate abstract or conceptual ideas into tangible actions, plans, or products. It includes the ability to strategize, plan, organize resources, and execute tasks in a way that aligns with the new or changed ideas. Essentially, it's about bringing creativity and innovation to fruition by developing and implementing a concrete outcome that reflects those ideas. In professional and personal contexts, individuals with this competency can play a key role in turning creative visions into reality and driving progress or change based on new or

adapted concepts. The successful execution of novel initiatives, the introduction of fresh products, or the provision of innovative services relies on an individual or a team possessing a strong concept - and nurturing that concept beyond its initial stage (Amabile, Conti et al. 1996). A process involving the creation, nurturing, and application of novel concepts or actions (Damanpour 1996).

An explanation of the four-part components refers to the ability of an individual to effectively bring about new or better outcomes or solutions for the individuals or groups he or she confronts or serves. This competency includes several key elements. Cognitive Competence: it indicates that an individual has the mental skills and abilities needed to understand, plan, and implement new or improved outcomes. This may include problem-solving skills, critical thinking, and decision-making skills. 2. Implementation: This component of the competency involves taking concrete steps to put the recommended results into practice. It includes tasks such as organizing resources, managing processes, and overseeing the execution of the plan. 3. New or Improved Outcomes: Individuals focus on introducing entirely new or improving existing outcomes or solutions. This means that they strive to bring positive change or innovation to recipients. 4. Targeted: Implementation is intended to benefit or serve a specific target audience, group, or individual (i.e., the target). The competency ensures that outcomes are relevant and valuable to the target audience. Having this competency is critical in a variety of professional roles such as project management, customer service or leadership. It enables individuals to identify opportunities for improvement, design solutions, and successfully implement them to meet the needs and expectations of the individuals or groups they are dealing with. The integration and utilization of new technologies, products, or procedures in a collective, firm, or broader community with which the relevant adoptive unit is unfamiliar, For the betterment of the collective, individual, or entirety of society(West and Anderson 1996). The successful execution of a novel offering, solution, or procedure which typically leads to their commercial triumph (Gordon and McCann 2005).

To summarize, an explanation of the five-part components refers to an individual's ability to understand, embrace, and utilize a fresh or enhanced result or solution that offers additional benefits or advantages, the components of this competency. In various professional and personal contexts, having this competency is valuable. It means that the individual can recognize the value of new ideas or improvements, adapt to them, and leverage the added benefits to achieve better results or outcomes.

2.1.4 Characteristics of Innovative Thinking

According to Guilford (1967), who supported contemporary innovative investigation, it was emphasized that during engaging in creative endeavors, inventive cognition serves as a tangible expression of personal ingenuity. He views innovative thinking characteristics as fluency, flexibility, originality, and elaboration (Fang 2020). Fluency refers to the capacity to continuously express a multitude of ideas and assumptions within a brief timeframe. Flexibility entails the ability to think adaptively from various perspectives and directions. Originality encompasses generating unique, inventive, and problem-solving concepts. Elaboration involves envisioning and describing specific details pertaining to objects or events. According to Burut (2018), innovative thinking is characterized by the inclination to explore possibilities, venture beyond comfort zones, and demonstrate persistence in transforming ideas into actuality (Burut, Mustapha et al. 2018).

In China, Innovative thinking characteristics contain breakthroughs, originality, flexibility, and comprehensiveness(Fang 2020). The nature of innovative thinking lies in its originality, transcendence, and unrepeatability (Xu and Chen 2010). Innovative thinking is flexible. Innovative thinking is individualized(Gao 2021). To engage in innovative thinking, individuals must be willing to accept and navigate uncertainty and ambiguity, make strategic decisions that involve risk-taking, and maintain perseverance even when faced with obstacles.

In summary, innovative thinking in this paper should be characterized by the following 1) Problem Definition: Undergraduates possess the ability to effectively

define a problem 2) Creativity: Undergraduates possess strong observational skills 3) Linking: Undergraduates master the ability to generate new ideas, iterate, and link 4) Idea Applicability: Undergraduates are bold enough to experiment with ideas and operationalize them in real-life situations 5) Outcome-Focused: Undergraduates are effective at obtaining outcomes that have tangible, innovative value.

2.1.5 Measurement of Innovative Thinking

According to existing literature, a widely accepted assessment tool for evaluating innovative thinking has yet to be established(Zhan, Shen et al. 2022). Measurement of innovative thinking can be traced back to the pioneering functionalist psychologist Galton's "free-association" tests(Nelson, McEvoy et al. 2000), free association tests have been widely used in memory and cognition research to assess associations between words and understand the underlying processes. Through literature comparison and research, it was found that most of the current research findings are focused on the use of Williams' creativity assessment packet and Torrance test of creative thinking (TTCT) measurement methods. We explained in detail the relationship between creativity and innovative thinking in our previous concept. The relationship between creative thinking and innovative thinking has been proposed, suggesting that these two forms of thinking are interconnected and intertwined during the actual thought process(Dou, Li et al. 2021). Creative thinking is characterized by its originality, divergence, and appropriateness, emphasizing imaginative thoughts. On the other hand, innovative thinking involves regenerative thoughts driven by the application and popularization of new technologies and products. It focuses on both social and economic benefits while aiming to enhance value through value addition. Notably, innovation thinking is a subset of abstract thinking (Dou, Li et al. 2021). However, in practical terms, these two types of thinking are closely intertwined with mutual influence (Dou, Li et al. 2021).

Williams Creativity Assessment Packet (WCAP) is a universal tool used to measure creativity(Williams 1993). The creativity index in this study was determined based on the scores obtained by each participant on the WCAP. The WCAP consists of

four dimensions, namely risk-taking (12 items), curiosity (13 items), imagination (13 items), and complexity (12 items) as described by (Du, Wang et al. 2020). The article employed the Williams creativity assessment package as a tool for evaluating creative personality. Participants were asked to rate their agreement with each item on a three-point Likert scale, ranging from 1 (definitely false) to 3 (definitely true). The Williams creativity assessment package was utilized to measure creative personality, the findings of this research demonstrated a correlation among regulatory focus, motivation, and creative abilities in individuals during their adolescent years. The Williams creativity assessment package is a tool used to assess the creative ability of the subjects (Jampole, Mathews et al. 1994). The participants of the research were exceptionally talented students who were registered in eight separate classes for third and fourth graders across three public elementary schools located in the southeastern region. The conclusion is that the Williams creativity assessment package helped categorize the subjects into high and low-creative groups based on their performance on drawing completion tasks. The high creativity group showed higher levels of originality in their writing, and the imagery group demonstrated the most significant improvement in originality and sensory descriptions after the training sessions.

Creativity can be evaluated using psychometric methods and concepts associated with intelligence (Guilford 1967). He identified several factors of divergent thinking that have had a significant impact on research in the field of creativity. A well-known assessment tool for measuring creativity is the Torrance Test of Creative Thinking (TTCT) developed by Torrance EP in 1974. The primary assessment tool utilized during the period from the 1960s to the 1980s was TTCT, which stands for Torrance Tests of Creative Thinking. Developed by r. E. Paul Torrance, widely recognized as the 'Father of Creativity,' this test was first introduced in 1966 and underwent four name changes in subsequent years: in 1974, 1984, 1990, and 1998. The TTCT consists of two versions (A and B) for both verbal and figural assessments (Kim 2006). The evaluation of creativity has been influenced by the methodology employed in its examination. The Torrance Test of Creativity Thinking (TTCT) assesses fluency, flexibility, originality, and

elaboration. Several researchers have proposed that identifying creativity can be based on the interests and attitudes expressed by the individual performing the actions (Chuang, Zhi-Feng Liu et al. 2015). The TTCT-Figural is primarily utilized for identifying children eligible for gifted programs, offering a valuable addition to the assessment toolkit. This is particularly significant as many existing methods of identifying gifted students heavily rely on verbal and quantitative content, focusing mainly on measuring achievement and aptitude in these specific areas (Torrance 1966). For instance, in Georgia, numerous school systems employ the TTCT as a measure of creativity when selecting students for their gifted programs. To qualify for admission into these programs, students must achieve at least the 90th percentile score on the TTCT (Chuang, Zhi-Feng Liu et al. 2015).

The aim of the Generic Innovation Skills Aptitude Test (GISAT2.0) is to enhance recognition and comprehension of the competencies, mindsets, and actions essential for individuals and organizations to foster innovation, as outlined in the Conference Board of Canada's Innovation Skills Profile 2.0 (Test 2000). By identifying and evaluating individuals' innovation skills and organizations' requirements, GISAT2.0 serves as a valuable instrument for aligning workplace and individual innovation capabilities with their respective needs for innovation(Test 2000). GISAT2.0 is a user-friendly and practical tool that enables individuals and organizations to assess their innovative abilities while considering how well these skills match their job responsibilities. The reliability and validity of aptitude tests for general creative skills have been examined previously. The generic Innovation Skills Aptitude Test functions as a research tool to evaluate Choice determination abilities, Viability, practicability and effectiveness while enhancing consciousness and comprehension of the necessary competencies, mindsets, and conduct required for individual and organizational innovation(Zhan, Shen et al. 2022). In addition, it evaluates the specific innovation competencies needed by individuals and organizations to align their requirements with suitable innovation capacities(Zhan, Shen et al. 2022). The General Innovation Skills Aptitude Test as a foundation for developing the Innovation Skills Assessment (ISA) tool,

the ISA is a structured survey comprising closed-ended questions derived from GISAT 2.0, which has been validated by the Conference Committee of the Canadian Business Innovation Centre (Test 2000) (Tahir, Sajid et al. 2023). The study aims to employ ISA tools for evaluating these capabilities within the four dimensions of innovation: idea generation, calculated risk-taking and entrepreneurship, relationship development and maintenance, and transformation of ideas into products, processes, and services. There are also Boza studies that have also validated the feasibility of the tool. He assesses the initial proficiency of students in the areas of innovation, creativity, and entrepreneurship. The examination measures four fundamental aspects of innovative abilities: skills in generating ideas, willingness to take risks, aptitude for building relationships, and ability to transform concepts into products, processes, or services. The assessment consists of two sections wherein students evaluate the essential skills required by professionals in their respective fields and also assess their own current skill levels (Boza, Cuenca et al. 2018).

Measuring tool	Compiler	Measurement objects	Test content
Ideas Generation Implementation (IGI)	Passig, & Cohen 2014	university student	Identifies the different styles of innovators and measures the implementation potential of ideas generated by these styles in six technology areas. The tool consists of six global problems, which are considered ill-defined, and students are asked to develop possible solutions for each problem with reference to two dimensions of the innovation dimension - the component and structural dimensions - and to compare them with those dimensions in existing or similar technologies.
Innovative	Scott &	company	The tool focuses on managers rating

Behavior Measure (IBM)	Bruce,1994	employee	the innovative behavior of their subordinates
Kirton Adaption-Innovation Inventory (KAI)	Kirton, 1976	Government agencies, aviation agencies	A tool for measuring a fundamental aspect of personality is the Kirton Adaption-Innovation Inventory (KAI) questionnaire. It evaluates a spectrum that ranges from adaptability, the ability to enhance existing methods, to innovation, the capacity to approach tasks in new and unique ways. This assessment instrument is based on an analysis of three relevant dimensions of personality: creativity, effectiveness, and adherence to rules/group norms. These dimensions are somewhat limited and specifically relate to transformative changes within organizations.
The Innovative Behavior Scale (IBS)	Lorenzo Lucianetti , 2016	company employee	Measurement of Employee Performance Appraisal,Creative Behavior, Idea Generation, Idea Dissemination, Idea Implementation.
Innovative Thinking in Education (ITE) scale	Bark, 2020	university student	The innovative Thinking Scale is a valid and reliable tool for assessing individual differences in innovative thinking among engineering students.

			It can be used for self-assessment and research purposes to facilitate the development of educational programs that foster creative skills. The innovative Thinking Scale consists of 13 items divided into four subscales/factors: Observation (3 items), Questioning (3 items), Networking (4 items), and Exploration (3 items). It was modified from the Innovative Behavior Scale (Barak ea tl).
Williams Creativity Assessment Packet (WCAP)	Williams, 1980	Students from kindergarten to 17 years old	WCAP consists of four dimensions: adventurousness (12 items), curiosity (13 items), imagination (13 items), and complexity (12 items)
Torrance Test of Creative Thinking, (TTCT)	Torrance (1974)	Students from kindergarten to 17 years old	The Torrance Test of Creativity Thinking, (TTCT) evaluates fluency, flexibility, originality and elaboration.
The General Innovation Skills Aptitude Test	Conference Board of Canada,	Individuals and organizations,	Includes 2 parts: A self-assessment (the degree to which you demonstrate a particular

(GISAT2.0)	2013	university students	innovation skill, attitude, or behaviour); B job-assessment (the importance of a particular innovation skill, attitude, or behaviour to your job).

FIGURE 3 Related innovative thinking scale information

Bark, 2020 the innovative thinking scale consists of 13 items divided into four subscales/factors: observation (3 items), questioning (3 items), networking (4 items), and exploration (3 items). It was modified from the Innovative Behavior Scale(Barak, Watted et al. 2020).Therefore, the scale used in this study demonstrated good validity and reliability for measuring innovative thinking. Lack of measurement of ability to translate ideas into products, implementations and presentations.

To summarize, the scale chosen for this study is The General Innovation Skills Aptitude Test(Test 2000).

2.1.6 Strategies to Promote Innovative Thinking

A review of relevant studies found that, teachers can have much influence on increasing student innovative thinking to learn by using strategies. A training series can be implemented for enhancing planning skills(Riley 2003). This involves initiating the learning process by formulating questions or a set of questions to determine the objective of the activity and then proceeding with specific steps. Modeling strategy: Jawan (1999) highlighted that one highly effective approach to learning is through modeling, especially when accompanied by illustrations and explanatory comments provided by the model. Self-speech strategy: emphasized the use of thinking aloud as a technique where individuals vocalize their thoughts while reading (Baumann, Jones et al. 1993). The aim of this strategy is to support students in enhancing their capacity to oversee their comprehension of reading and utilize tactics for managing and promoting

their cognitive processes. Rephrased: the strategy of asking oneself questions is crucial for cognitive development as it encourages students to actively seek answers and information that they personally want to know(Ciardiello 1998). By engaging in self-questioning, learners can assess their own strategies, identify key points, provide supporting details, and establish connections between the content and their own experiences. In terms of direct teaching strategy, teachers should follow a specific approach which involves introducing the skill by writing its name, presenting outlines and examples of potential difficulties (Jarwan 1999). A student interaction strategy where students are encouraged to engage in critical thinking by reflecting on others' work(Tanner and Jones 2002). Cooperative learning strategy, as mentioned emphasizes forming small groups within the classroom setting to foster collaboration and group work for effective learning outcomes(Ashman and Conway 2002). Lastly, self-assessment strategy focuses on metacognitive thinking with two components: individual awareness of one's cognitive behavior during learning tasks and the ability to plan alternative strategies when faced with difficulties(Wilen and Phillips 1995).

From the research perspective of this dissertation, this paper focuses on the study of innovative thinking using modeling strategies. project technique is effective in reaching targets in the cognitive domain(Chen, Lai et al. 2022). So, the utilization of the Project-Based Learning approach serves as a highly effective method to foster and cultivate innovative thinking. Substantial evidence supports the notion that engaging in Project-Based Learning significantly influences and enhances one's capacity for innovative thinking. The implementation of a Project-Based Learning STEM approach in education can enhance students' scientific process skills and foster their creativity (Lestari, Sarwi et al. 2018). Pramada concludes that learning with Project-Based Learning can achieve the desired goals, teachers must plan for learning, and Project-Based Learning model can be a learning solution for the 21st century (Prananda, Proboningrum et al. 2020). Saimon ound that implementing Project-Based Learning improved the 4Cs of students at the University of Tanzania(Saimon, Lavicza et al. 2023)f.

Relevant research proves that project-based learning is indeed a feasible teaching strategy to cultivate innovative thinking.

2.1.7 Research Related to Innovative Thinking

Reviewing the relevant literature, many scholars have conducted fruitful research. Particularly in the field of education, the current direction of research on innovative thinking appears to involve an interdisciplinary and holistic understanding that emphasizes its application in educational settings, recognizes the need for reliable measurement tools, and explores practical pedagogical approaches. This multidimensional approach reflects the complexity of innovative thinking and its importance in various fields.

Morad, S., Ragonis, N., & Barak, M. analyze the topic “An integrative conceptual model of innovation and innovative thinking based on a synthesis of a literature review”. The primary objective of this study is to construct a comprehensive conceptual framework for innovation and innovative thinking, particularly in the field of education(Morad, Ragonis et al. 2021). This will be achieved by analyzing and integrating 100 different meaning of innovation from diverse fields of study, resulting in a holistic comprehension. Extensive literature review was conducted to gather relevant information from diverse sources, which were then synthesized into a conceptual framework encompassing the essence of innovation and its underlying cognitive processes. The findings indicate that the global conceptual model comprises five distinct cognitive abilities. Consequently, this comprehensive framework holds significant value in comprehending innovation and fostering innovative thinking within educational environments across all age groups.

Morad, S., Ragonis, N., & Barak, M. researched the topic “The validity and reliability of a tool for measuring educational innovative thinking competencies. The objective of this research is to establish a dependable and valid tool for evaluating competencies associated with creative thinking in the field of teacher training(Morad, Ragonis et al. 2021). The researchers aimed to fulfill the need for an assessment tool that specifically focuses on education, while also examining the innovative thinking

abilities of future educators. The research inquiries primarily concentrate on verifying and confirming the validity and reliability of the questionnaire on innovative thinking, including content validity, structural validity, and concurrent validity. The research methodology comprises a three-stage approach for developing and validating the analysis of validity. The research process involved multiple phases, such as evaluating content validity through evaluator consistency, employing principal component analysis and Cronbach's alpha to assess structural validity and reliability respectively, as well as conducting parallel validation analysis by examining correlations between different scales. A total of 318 university pre-service teachers volunteered to participate in this study. Various quantitative data analysis techniques were utilized, including evaluator consistency evaluation, exploratory factor analysis, confirmatory factor analysis, and correlation examination to establish the credibility and dependability of the tool. Based on the findings from this study, we have developed a self-report questionnaire called "Educational Innovative Thinking Ability Self-Report Questionnaire (EITC-SRQ)", which consists of 17 items categorized into four main competency areas: observation skills proficiency; questioning ability; idea network proficiency; experimentation capability. The EITC-SRQ demonstrated satisfactory levels of both validity and reliability based on our quantitative analyses. In conclusion, our findings indicate that the EITC-SRQ is an effective instrument for measuring innovative thinking competencies within the field of education while also providing valuable insights for assessing and fostering these competencies among preservice teachers.

The topic" A cultural perspective to Project-Based Learning and the cultivation of innovative thinking". The objective of this study was to examine the impact of project-based learning on the development of innovative thinking among both international and local students in China(Barak and Yuan 2021). To gather comprehensive insights into real-life situations, an examination utilizing the case study method with selected participants, commonly employed in the field of social science research, was utilized for data collection. Non-parametric tests were employed when the assumption of normal distribution could not be made due to the relatively small sample

size, ensuring statistical accuracy and appropriateness. To assess the participants' perception of innovative thinking, a self-report questionnaire was utilized. This questionnaire underwent rigorous psychometric and statistical validation procedures. The findings indicated that disparities in innovative thinking primarily stem from differences in learning behaviors and cultural norms among students. It is strongly recommended that higher education institutions consider students' backgrounds and behaviors.

The topic “Establishing the validity and reliability of a modified tool for assessing innovative thinking of engineering students. “The aim of this research was to develop and validate a self-report instrument called the Innovative Thinking Scale, which assesses variations in innovative thinking among engineering students(Barak, Watted et al. 2020). The primary objective of this study is to establish the reliability and validity of the scale using a five-step validation process. This investigation aimed to evaluate the content validity, structural validity, known population validity, global and temporal stability, as well as simultaneous validity of the scale by involving over 4,000 participants from diverse engineering disciplines, industries, and research centers worldwide. These participants were enrolled in an online course focused on nanotechnology and nano sensors. To assess the scale's validity and reliability, experts in engineering education evaluated its content validity while both exploratory factor analysis and confirmatory factor analysis were employed to determine its structural validity. Known-groups validity was examined by analyzing differences between subgroups. The stability of the scale across populations and time was also evaluated without any intentional interventions. Concurrent validity was reinforced by comparing participants' actual practice in designing innovative nano sensors with their scores on the Innovative Thinking Scale. The study's findings indicate that individuals with a deeper understanding of nanotechnology tend to score higher on this scale, thus demonstrating known-groups validity. Furthermore, the scale exhibited stability over different populations and time periods when no deliberate interventions occurred. In conclusion, this study confirms that the Innovative Thinking Scale is a reliable and valid tool for assessing variations in

innovative thinking among engineering students. Its application can greatly contribute to educational programs aimed at fostering innovation.

Root-Bernstein researched the topic “Intuitive tools for innovative thinking.” The purpose of this study is to emphasize the role of intuitive thinking skills in creative endeavors, particularly in the arts and sciences(Root-Bernstein and Root-Bernstein 2003). The authors argue that creative thinking is closely tied to intuition and aesthetic experience. The study aims to highlight the importance of recognizing and exercising intuitive thinking skills in educational efforts to promote creative thinking. The research inquiries focus on comprehending the processes that convert personal thoughts into objective modes of expression, as well as investigating the non-verbal, non-logical foundation of imaginative cognition. The results imply that any theory aiming to elucidate innovative thinking must consider the sensory, emotional, and physical manifestations of thought alongside its analytical and objective aspects. The authors underscore the significance of both intuition and abilities in fostering creativity and innovation.

Research in the book “Sparking student creativity: Practical ways to promote innovative thinking and problem solving.” The purpose of the book is to provide practical ways to promote innovative thinking and problem-solving skills in students(Drapeau 2014). The questions are focused on how to teach creative thinking, how to make creativity intentional in the classroom, and how to promote *innovative* thinking among disengaged students. The research methodology includes providing tools, strategies, and examples to foster creativity in the classroom. The results of the study include a roadmap to creativity, suggestions for designing creative lessons, and strategies for promoting *innovative* thinking and problem-solving skills. Overall, the study aims to help teachers increase student engagement and achievement through creative instruction.

In summary, these studies provided different perspectives and approaches that laid the foundation for my dissertation. An integrated conceptual model of innovative thinking provides a powerful framework for educational settings that is consistent to develop innovative thinking skills in college students. It is useful for higher education

institutions to foster innovative thinking through a project-based learning approach. From related studies, it was found to be helpful to develop an innovative thinking scale for educational programs that promote innovation, and the scale has good reliability and validity. These studies support the implementation of project-based learning to enhance innovative thinking among college students by providing validated models, tools, cultural perspectives, and practical strategies, and integrating these insights can strengthen the theoretical framework and practical application of this research paper.

2.2 Project-Based Learning

The utilization of Project-Based Learning as an instructional strategy to foster innovative thinking in tertiary education underscores the capacity of Project-Based Learning to actively involve students in authentic and unconstrained challenges, leading to improvements in critical thinking abilities, drive, and involvement (Barak and Yuan 2021). Project-Based Learning is a Project-Based teaching mode with life experience as orientation and "real problems" as the core. It aims to integrate students into a meaningful task-completion process to achieve Learning goals (Liu and Zhao 2021). Project-Based Learning is one of the higher-order thinking skills used to improve the process's quality and learning outcomes (Simbolon and Koeswanti 2020). The four key characteristics of project learning should have taking personal accountability for one's own thinking and acquisition of knowledge; recognizing the importance of societal obligations; applying scientific reasoning in a practical manner and connecting group dynamics and outcomes to professional implementation(Kleijer, Kuiper et al. 1981).

2.2.1 Definition of Project-Based Learning

Originating in the United States, Project-Based Learning go back to of learning education(Dewey 1933). Famous educator William Heard Kilpatrick first proposed the concept of the project, he refers to students learning through the completion of projects closely related to real life, which is a full selection and use of optimal resources, in the practice of experience, internal absorption, exploration and innovation in the development of practical activities a design of pedagogical methods (Heard Kilpatrick 2020). An educational method that incorporates real-life situations for

learners to tackle challenges or create solutions(Moss and Van Duzer 1998). The Buck Institute for Education positions Project-Based Learning as a systematic approach to teaching and learning. It involves the active participation of students in acquiring knowledge and skills by means of an extensive investigation process centered on intricate, genuine inquiries and meticulously crafted deliverables and assignments (Markham, Larmer et al. 2003). This can be compared to the definition of Project-Based Learning provided by intricate tasks centered around challenging inquiries or issues(Thomas 2000). This method involves students in tasks like designing, solving problems, making decisions, or conducting investigations. It also allows students to work relatively independently for extended periods and culminate their efforts with realistic products or presentations (Kokotsaki, Menzies et al. 2016). According to, project-based learning can be defined as a teaching method that includes like engaging students in projects with processes and products, students part of the project ownership, over a longer period of time, from days to weeks or even months, Integrate various skills in the project(Stoller 2006) (Grant 2002). Develop students' understanding of specific topics through the integration of language and content, Promote cooperation among colleagues while also allowing individuals to work; Hold students accountable for their learning by requiring them to collect, process and report information from target language resources, Assign new roles and responsibilities to students and teachers involved in the project, Tangible end products as evidence of achievement, reflection on the process undertaken during the project and its final product is encouraged. it lays great emphasis on the Communication and integration.The core of Project-Based Learning lies in utilizing a question or problem to structure and propel activities, ultimately resulting in a final product that tackles the central inquiry(Blumenfeld, Soloway et al. 1991). In a study discovered that definitions encompass resolutions to an issue through collaborative efforts among students(Kubiatko and Vaculová 2011). Furthermore, the culmination of student work often involves the development of various outputs such as a thesis, report, design plan, or model. Project-Based Learning aspect of students actively engaging in global observations and seeking inquiries about the

current equipment situation them with the ability to think creatively and generate new ideas(Barak and Yuan 2021). and engages students in the process of conceptualizing or reimagining a product or system, or fabricating a tangible item that is linked to regarding the educational environment (Usher and Barak 2020). In a recent investigation determined that Project-Based Learning is an educational approach centered around real-life experiences and focused on addressing authentic challenges(Liu and Zhao 2021). The primary objective of this teaching model is to engage students in a purposeful task-oriented process, ultimately leading to the attainment of learning objectives.

In China, Mr. Tao Xing Zhi, a famous educator, indicated that the educational concept of "Acting is the beginning of knowing and knowing is the completion of acting" in his article "Acting is the beginning of Knowing" as early as 1928, emphasizing the integration of "knowing" and "acting", which is like the effect of Project-Based Learning. China witnessed the emergence of Project-Based Learning in the 2000s, which gained widespread popularity during the owing to its ability to significantly enhance students' deep learning and foster their academic achievements, along with the development of core competencies(Zhou and Li 2022). Chinese scholars are more engaged in a kind of synthesized and combined use of Project-Based Learning definitions. Project-Based Learning is an innovative form of inquiry-based education that focuses on core concepts and principles within a particular field of study. Its primary goal is to create and market tangible products or solutions to real-world customers. This approach involves conducting practical investigations using a wide range of resources and addressing interconnected problems within a specified timeframe. In essence, Project-Based Learning combines academic knowledge with practical application, fostering critical thinking and problem-solving skills in a real-world context. It focuses on hands-on learning through project work, combining knowledge and problem-solving to create artistic project results.

According to the definitions listed, in this article, Project-Based Learning is an open-ended inquiry-based approach to teaching and learning. It enables students to

have the observational skills to identify problems based on the real-world problems and tasks provided, the creativity to stimulate new ideas, the ability to use innovative tools for continuous inquiry, the ability to form links with the ability to implement the results of the product through effective product development, and the ability to realize the personal cognitive abilities of the product's social added value.

2.2.2 Essential of Project-Based Learning

The educational principles advocated by John Dewey are in line with the main goals of Project-Based Learning approaches, which aim to bridge the gap between theoretical knowledge and practical applications by addressing real-life challenges that are pertinent to learners' future professional settings(Fernandes 2014). From the theoretical study of Project-Based Learning should include the following essential elements: (1) projects (2) they involve initiative by the student or group of students (3) they commonly result in an end product (4) work often goes on for a considerable length of time; (5) teaching staff are involved in an advisory(Adderley 1975). The core of Project-Based Learning lies in engaging in projects that involve problem-solving, often initiated by the students themselves, and leading to a final outcome that represents the essential elements of Project-Based Learning(Helle, Tynjälä et al. 2006). Project-Based Learning entails using a question or problem as a guide and motivation for activities, ultimately resulting in the creation of a final product addressing the central inquiry(Blumenfeld, Soloway et al. 1991). In Erdogan's study, Project-Based Learning encompasses initiation, management, deliverables, and assessment (Erdogan and Bozeman 2015). A project becomes significant when it fulfills two conditions: firstly, students perceive it as personally meaningful and are motivated to excel; secondly, it serves an educational objective. An effectively designed and executed approach to Project-Based Learning incorporates both aspects of that the Seven Essentials for Project-Based Learning are (1) a need to know (2) a driving question (3) student voice and choice (4) 21st century skill (5) inquiry and innovation (6)feedback and revision (7) a publicly presented product(Larmer and Mergendoller 2010). Shortly after, Larmer included an additional component to address misconceptions that Project-Based

Learning was ineffective in imparting knowledge, comprehension, and skills aligned with standards. This served as a reminder for educators to develop projects that prioritize content standards (Larmer, Mergendoller et al. 2015). It is called gold standard Project-Based Learning to help ensure students are getting the main course and are engaged in quality Project-Based Learning.

2.2.3 Characteristics of Project-Based Learning

A consistent set of characteristics attributed to Project-Based Learning has been identified by educators who have conducted thorough investigations into this pedagogical approach.

Project-Based Learning is one of the higher-order thinking skills used to improve the process's quality and learning outcomes (Simbolon and Koeswanti 2020). The characteristics of project learning have like a taking personal accountability for one's own thinking and acquisition of knowledge; recognizing the importance of societal obligations; applying scientific reasoning in a practical manner; connecting group dynamics and outcomes to professional implementation (Kleijer, Kuiper et al. 1981).

In current undergraduate education, Project-Based Learning have **Real-world problems characteristics ,it i**nvolves finding and solving real-world, complex, and uncertain problems creatively, so as to have a positive social impact(Acharya, Bhatt et al. 2023). The primary objective of Project-Based Learning is to actively engage learner in the educational process, fostering an environment that encourages their participation and openness. The primary objective of Project-Based Learning is to actively engage learner in the educational process, fostering an environment characterized by openness. Teachers create problem situations and pose questions that stimulate critical thinking among students regarding the topic at hand (Kubiatko & Vaculová, 2011).

Project-Based Learning is an instructional approach that focuses on students and their active involvement in the learning process. It is guided by three constructivist principles: context-specific learning, collaborative interactions, and the acquisition of knowledge through sharing and understanding(Cocco 2006).Based on the research, Project-Based Learning is characterized by a focus on student-centered

learning, learning taking place in small group settings, teachers assuming the role of facilitators or guides, problems being used as the central focus and catalyst for learning, problems serving as a means to enhance clinical problem-solving skills development, and self-directed learning playing a crucial role in acquiring new information. Project-Based Learning have **driving engagement characteristics,** students' voices and choices in Project-Based Learning, driving engagement through essay writing and infographic design(Sukerti, Yuliantini et al. 2018).

According to Markula, Project-Based Learning encompasses various characteristics, such as the use of driving questions, learning goals, scientific practices, collaboration, technological tools, and the creation of a tangible artifact (Markula and Aksela 2022). This unique approach involves students constructing a product that represents their newfound understanding and knowledge on the subject being investigated. These artifacts can take various forms like videos, photographs, sketches, reports, models or other collected items(Holubova 2008). Additionally, Project-Based Learning is characterized by its authenticity, interdisciplinary nature and student-centered approach. It promotes initiative learning and cooperative learning while encouraging progressive inquiry (Liu and Zhao 2021). It identified five essential features of projects: centrality in curriculum design; incorporation of driving questions; constructive investigations; autonomy for students; and realism in project outcomes(Thomas 2000). Other publications emphasize the significance of student collaboration, reflection on their work process through redrafting stages and final presentations (Kwon, Wardrip et al. 2014);(Patton 2012). A model for effective Project-Based Learning includes key elements such as alignment with core curriculum objectives across multiple disciplines; sustained engagement over time for students; involvement in decision-making processes by students themselves; collaborative efforts among participants; clear connections to real-world contexts; systematic assessment throughout the project duration as well as at its completion stage (Kalyoncu and Tepecik 2010).

To summarize, Project-Based Learning is an instructional method that encourages hands-on learning, fosters social consciousness, applies knowledge in real-world scenarios, and cultivates skills applicable to both academic and professional settings. Encourage real-world learning activities that include authentic resource use and technology impact in a collaborative learning atmosphere and use a variety of skills, such as thinking skills. Students can connect ideas, gain new skills to complete their product, and can receive final feedback from their peers and teachers after the learning phase. The characteristics mainly contain (1) solving real-world problems, student engagement, construction of a product, self-responsibility for thinking and learning (2) awareness of social responsibility (3) thinking and acting from the scientific perspective but in a practical application (4) relating both group process and product with professional practice. These characteristics emphasize the interactive participatory, realistic, continuous inquiry, and student-centered nature of this educational approach.

2.2.5 Advantages and Limitations of apply Project-Based Learning

According to a study the implementation of Project-Based Learning resulted in increased enthusiasm and active engagement among students when it comes to exploring knowledge and acquiring new skills(Kanevsky and Keighley 2003). By incorporating Project-Based Learning into the curriculum, students are less likely to feel bored or unmotivated during the learning process. While it is true that Project-Based Learning may not be suitable for every situation, there are several benefits associated with this approach. These include motivating students, preparing them for future learning activities, helping them meet academic standards and perform well on tests, enabling teachers to teach more effectively, and fostering connections between schools, parents, communities, and the wider world. Through goal-setting, planning, organization, collaboration with peers through social learning experiences, and being given some autonomy in their learning journey at an appropriate level, students develop self-reliance skills while also becoming intrinsically motivated(Bell 2010). It is worth noting that Project-Based Learning has been follow through across various educational

contexts from early childhood education all the way up to higher education (Kokotsaki, Menzies et al. 2016).

Studies have pointed out the positive impact of Project-Based Learning on students' cognitive skills, motivation to learn, and active engagement(Sasson, Yehuda et al. 2018, Kuo, Tseng et al. 2019, Wu and Wu 2020). By presenting real-world problems for students to solve, Project-Based Learning can effectively contribute to the development of their problem-solving ability (Li and Jiang 2023).

One notable benefit can be observed in the field of higher education, where Project-Based Learning is widely supported as an effective teaching approach that fosters significant learning and profound comprehension by connecting Theory and knowledge, students' daily experience (Barak and Usher 2019). Compared to other teaching methods, we can see from the table that, Project-Based Learning often refers to an innovative, student-driven teaching method that aims to teach students “a multitude of strategies critical for success in the twenty-first century”(Bell 2010). The improvement of the educational experience for students in comparison to traditional teaching approaches (Thomas 2000). The utilization of Project-Based Learning as an instructional method has proven effective in promoting active participation, fostering critical thinking and analysis, encouraging holistic problem-solving skills, nurturing creativity, and cultivating cultural sensitivity (Du, Su et al. 2013). Based on a synthesis of theoretical and practical knowledge, the methodology for integrating the principles of Project-Based Learning with available information and communication technologies is presented and demonstrated, providing implementation guidelines for lecturers and higher education institutions (Shpeizer 2019). Project-Based Learning is a pedagogical approach that provides a structured framework for actively involving students in the genuine exploration of real-world and open-ended challenges through collaborative teamwork. The literature has already confirmed the benefits of Project-Based Learning in enhance students' higher-

	Connotation	Characteristics	steps
Problem-based learning	Teacher-centered pedagogy, i.e.,teacher-centered instruction with clear steps that students then follow to consolidate knowledge and skills.	1. clear step-by-step strategies 2. mastery of each step of the process 3. strategies (or processes) to correct student errors 4. use of adequate examples 5. teachers providing feedback and guidance	Break down instructional tasks into small steps through explicit teacher instruction
Direct instruction	A pedagogical approach that prioritizes the teacher's role, involving lectures or practical demonstrations to present information in a systematic manner. Subsequently, students are guided to follow instructions for reinforcing their knowledge and skills.	1. clear step-by-step strategies 2. mastery of each step of the process 3. strategies (or processes) to correct student errors 4. use of adequate examples 5. teachers providing feedback and guidance	Breaking instructional tasks into small steps through explicit teacher-led instruction
Project-Based Learning	General learner-centered pedagogy that organizes learning around projects with a focus on facilitating inquiry, problem solving and investigating question.	1) self-responsibility for thinking and learning;2)awareness ofsocial responsibility;3) thinking and acting from the scientific perspective but in a practical application; 4) relating both group process and product with professional practice	Starting/plan Implementation and developing Reporting and communication activities Assessing

FIGURE 4 Comparison of Project-Based Learning and other pedagogic

promoting active participation, fostering critical thinking and analysis, encouraging holistic problem-solving skills, nurturing creativity, and cultivating cultural sensitivity (Du, Su et al. 2013). Based on a synthesis of theoretical and practical knowledge, the methodology for integrating the principles of Project-Based Learning with available information and communication technologies is presented and demonstrated, providing implementation guidelines for lecturers and higher education institutions (Shpeizer 2019). Project-Based Learning is a pedagogical approach that provides a structured framework for actively involving students in the genuine exploration of real-world and open-ended challenges through collaborative teamwork. The literature has already confirmed the benefits of Project-Based Learning in enhance students' higher-order thinking abilities, motivation to learn, and level of engagement (Sasson, Yehuda et al. 2018).

Project-Based Learning is a comprehensive approach that involves engaging students in inquiry-based learning. It encourages interdisciplinary connections and offers a broader perspective on subject matter. Additionally, Project-Based Learning can cater to diverse learners and adapt to various learning environments (Blumenfeld, Soloway et al. 1991). Moreover, it fosters creativity, critical thinking skills, effective communication abilities, collaborative teamwork, as well as self-directed exploration and lifelong learning competencies (Nelson 2017). Furthermore, Project-Based Learning is recognized for its support of social learning by equipping students with essential 21st-century skills such as communication, collaboration, and teamwork (Kokotsaki, Menzies et al. 2016). According to Quint and Conliffe, Project-Based Learning entails complex tasks that involve challenging questions or problems(Quint and Condliffe 2018). Students actively participate in designing solutions through problem-solving techniques while engaging in research activities(Handrianto and Rahman 2018). Throughout the project journey and interaction with their environment, students gain a deep understanding of the entire product development process encompassing conception, design implementation, and operation. They also encounter

unexpected insights during this interactive experience which facilitates knowledge acquisition while promoting knowledge construction and transferability (Liu and Zhao 2021).

Secondly: From the relevant studies, the current Project-Based Learning research on innovative thinking has only investigated students' perceptions of innovative thinking through a self-report questionnaire, although the questionnaire was created and validated through rigorous psychometric and statistical techniques (Barak, Watted et al. 2020). So based on this, research tool the paper adds peer evaluation and program outcome measurement reference tools to make the measurement data more precise.

Furthermore, the study's limitation stems from its restricted sample size, which may undermine statistical robustness and hinder the capacity to offer precise explanations (Field 2024). However, this paper mainly focuses on the precise part of a specific sample group, so it is still informative to a specific sample group within a specific scope, both by using the research method of designated participants. This approach is widely accepted in the field of social science research and contributes to a comprehensive comprehension of the actual circumstances (Creswell and Creswell 2017). The exploration of Project-Based Learning's effectiveness in enhancing students' innovation capabilities is still at an early stage (Barak and Yuan 2021). Consequently, there remains ample scope for further investigation into the realm of Project-Based Learning.

2.2.6 Related Studies of Project -Based Learning

Various research studies have examined thoroughly the efficacy of Project-Based Learning in undergraduate education across various nations (Kokotsaki, Menzies et al. 2016). Researchers and educators are working to test its effectiveness and many studies have been conducted. Foreign studies have focused on the implementation of Project-Based Learning in different fields and environments, including chemistry, integration of 21st-century skills, creative thinking in physics, and the development of innovative thinking skills. These studies reveal how Project-Based Learning can positively impact students' innovative thinking skills through real-world problem-solving,

integration with industry needs, and emphasis on subjective student engagement. This research offers valuable perspectives for the effective implementation and enhancement of project-based learning in order to inspire students' creativity when tackling real-life issues, devising inventive remedies, and confronting forthcoming obstacles.

The researched the topic “A review of research on project-based learning”. The purpose of the study is to conduct a comprehensive review of existing research on Project-Based Learning. The author aims to examine the benefits and challenges associated with project-based learning and provide insights into its impact on students' cognitive and social development. The review seeks to inform educators, policymakers, experts studying the efficacy of utilizing project-based learning as a teaching method. The study is a literature review, and the methodology involves systematically analyzing and synthesizing findings from various research studies related to project-based learning. A range of literature to identify common themes, trends, and outcomes associated with project-based learning(Thomas 2000). The review likely includes studies that explore diverse educational levels, subjects, and contexts to provide a comprehensive understanding of the impact of Project-Based Learning. The main findings of the reviewed studies are synthesized in the results of this study. The advantages of project-based learning, such as its potential to enhance student engagement, foster critical thinking skills, and encourage collaborative learning(Thomas 2000). The evaluation may address difficulties related to implementing project-based learning and may also highlight variations in outcomes across different educational environments. In summary, this comprehensive review presents an analysis of the benefits and challenges associated with project-based learning and its impact on students' cognitive and social development.

Researched the topic “Motivating project-based learning: Sustaining the doing, supporting the learning”. The purpose of the study is to explore the motivational aspects of Project-Based Learning and how these motivations influence sustained engagement in the learning process(Blumenfeld, Soloway et al. 1991). The authors aim to identify key factors that contribute to maintaining students' interest and commitment

during project-based activities, with a focus on sustaining the "doing" (active involvement in projects) and supporting the "learning" (academic and cognitive growth). The study might employ a combination of qualitative and quantitative data to investigate the factors that motivate students in project-based learning. Researchers could have observed classrooms where project-based learning is implemented, conducted interviews with both students and teachers, as well as administered surveys or assessments to measure motivation levels and learning outcomes. This approach may entail a systematic examination of the collected data to identify patterns and gain insights into motivation and engagement within project-based learning. The findings offer valuable perspectives on the motivational aspects of project-based learning. The authors discuss elements that contribute to sustaining student interest during the hands-on phase of this type of learning, highlighting the significance of relevance, autonomy, and authentic experiences. Furthermore, the research may explore strategies for supporting various aspects of project-based learning such as scaffolding techniques, feedback mechanisms, and creating supportive environments for effective learning. These findings enhance our understanding regarding how educators can design and facilitate engaging project-based learning experiences that not only foster academic growth but also promote cognitive development.

Researched the topic “Enhancing undergraduate students' chemistry understanding through project-based learning in an IT environment”.

The purpose of this study was to investigate the impact of integrated project learning on college students' understanding of chemical concepts, theories and molecular structures in an information technology environment(Barak and Dori 2005). Data were collected and analyzed using both quantitative and qualitative methods. Quantitatively, pre-test, post-test, and final exams were used to compare learning gains between the two groups. Qualitatively, the findings were examined to assess the impact of IT-rich project-based learning on students' understanding of chemistry. The results showed that the experimental group that engaged in project-based learning in an IT environment showed better learning benefits compared to the control group that

focused on traditional problem solving. The results show that integrating project learning in the environment rich in information technology is an effective way to improve college students' ability of understanding chemistry.

Pawar, R., Kulkarni, S., & Patil, S. (2020) investigated research in the topic “Project Based Learning: An Innovative Approach for Integrating 21st Century Skills”. The main aim of this study was to examine the impact of Project-Based Learning on the development of 21st-century competencies in sophomore mechanical engineering students. The data collection methods employed in this study included observations, evaluation rubrics, and student feedback. The findings indicated that students who participated in Project-Based Learning activities exhibited significant advancements in a range of 21st-century skills such as creativity, communication, time management, self-assessment, group collaboration, leadership abilities, and critical thinking. It was determined that the utilization of Project-Based Learning demonstrated its efficacy in fostering these essential abilities. This study provides substantial evidence supporting the notion that Project-Based Learning is a valuable pedagogical strategy for enhancing both skill development and learning outcomes within the field of mechanical engineering.

Mihardi research evaluated undergraduate students enrolled in the physics program at State University of Medan, utilizing essay tests comprising higher-order thinking questions (Mihardi, Harahap et al. 2013). The collected data was then analyzed using one-way ANOVA. Findings revealed that students exposed to the Learning model with KWL worksheets demonstrated superior innovative thought process abilities compared to those in the cooperative learning group. Additionally, an observer's observations indicated a positive increase in student engagement during the Project-Based Learning process. These results highlight the significant impact of Project-Based Learning on enhancing students' higher-order thinking skills, particularly within the realm of physics education.

Research on the topic “PBL Cultivation Mode of Innovative Thinking Ability Based on the Data of WTMF and TCT”. The primary objective of this study is to

investigate the innovative thinking ability of Chinese students in acquiring a second language and develop an instructional model(Ling 2021). To assess the innovative thinking ability of students studying different foreign languages, we employed WTMF (Williams Innovation Thinking Ability Tendency Measurement Form) and TCT (Test of Creativity). The findings revealed that students exhibited higher levels of curiosity, challenge, and adventure, but lower levels of imagination. They demonstrated commendable creativity while displaying average fluency and flexibility. Various demographic factors displayed consistency in terms of fluency, flexibility, originality, and creativity. Cultivating college students' creative thinking ability is crucial for addressing their strengths and weaknesses during the process.

The topic “A review of project-based learning in higher education: Student outcomes and measures”. The purpose of the study is to examine the effectiveness of Project-Based Learning in higher education, with a focus on student outcomes. The research methodology involved a systematic review of empirical studies on PjBL, with an emphasis on evaluating student outcomes related to affective, cognitive, and behavioral aspects. Various assessment methods, including questionnaires, interviews, rubrics, tests, and observation, were used to measure these outcomes(Guo, Saab et al. 2020). The results showed that in addition to affective outcomes, which are the most frequently examined in PjBL research, it is recommended that measurement tools and data analysis methods for PjBL in higher education be improved. The findings suggest that while PjBL in higher education has been widely studied in terms of affective outcomes, there is a need for a more in-depth examination of cognitive and behavioral aspects of student learning. This review may offer a comprehensive overview of how Project-Based Learning impacts student outcomes, including innovative thinking, and may highlight the effectiveness of Project-Based Learning in higher education settings.

Researched the topic “Project-based learning in education: Integrating business needs and student learning”. The aim of this case study was to examine the implementation of Project-Based Learning at Columbus Signature Academy (CSA), a high school situated in Columbus, Indiana, USA(Cho and Brown 2013). The data were

collected using a case study approach to provide qualitative insights into how PBL is used at CSA, with a focus on examining essential elements and challenges. The results showed that six emergent themes and evaluated the school's Project-Based Learning practice using a strengths, weaknesses, opportunities, and threats (SWOT) analysis. There was a significant highlight of the potential of Project-Based Learning as an innovative approach to teaching and learning, as well as for teacher professional development.

Patange, A. D., Bewoor, A. K., Deshmukh, S. P., Mulik, S. S., Pardeshi, S. S., & Jegadeeshwaran, R. (2019) investigated research on the topic “Improving program outcome attainments using project-based learning approach for UG course-mechatronics”. The purpose of this study is to develop the creative, inventive, and innovative thinking of the students as the curriculum is mostly limited to theories and methods of learning. The data collected involved the organization of large groups of over 70 students into smaller teams consisting of 3-5 members. These teams were assigned specific project phases and evaluated using both direct and indirect assessments aligned with desired outcomes. Surveys were conducted before and after the implementation of project-based learning to measure its impact on various aspects. The findings indicate that project-based learning is a highly effective instructional approach, leading to significant advancements in overall growth, collaboration, sustainability, critical thinking abilities, capacity for learning, interpersonal skills, self-confidence, and communication proficiencies. Notably, project-based learning not only enhances technical expertise but also cultivates a wide range of indispensable skills and qualities that students will highly value in their future professional endeavors such as innovation aptitude, problem-solving proficiency, and adaptability to dynamic environments(Patange, Bewoor et al. 2019).

The collected data involved organizing large groups of over 70 students into smaller teams consisting of 3-5 members. These teams were assigned specific project phases and evaluated through both direct and indirect assessments aligned with desired outcomes. Surveys were conducted prior to and after implementing Project-

Based Learning to measure its impact on various aspects. The findings indicate that project-based learning is an extremely effective instructional approach that leads to significant advancements in overall growth, collaboration, sustainability, critical thinking abilities, capacity for learning, interpersonal skills, self-confidence and communication proficiencies. Notably, Project -Based learning not only enhances technical expertise but also fosters a wide range of essential skills and qualities valued by students in their future professional pursuits, such as innovation aptitude, problem-solving proficiency, and adaptability to dynamic environments.

Sahin, A. (2015)investigated research on the topic “STEM students on the stage (SOS): Promoting student voice and choice in STEM education through an interdisciplinary, standards-focused project-based learning approach”(Sahin 2015). The purpose of this study is to investigate a new Project-Based Learning model in the STEM field, which has been developed by Harmony Public Schools (HPS). The data was collected through selective sampling and involved conducting interviews with 11 students from different grade levels. Grounded theory coding and continuous comparative analysis were utilized to analyze the transcripts of these interviews. The results indicated that the STEM S.O.S. model had a positive influence on students' understanding of concepts, as well as their interest in STEM and research, self-confidence, and proficiency in technology, life skills, career development, communication, and collaboration. It is important to note that interdisciplinary approaches to Project-Based Learning focused on meeting standards have the potential to significantly enhance students' involvement in STEM education and future career prospects.

In summary, the studies mentioned in this paper lay a strong foundation for the research presented here, offering valuable insights into the advantages, difficulties, and aspects of project-based learning. They support the idea that project-based learning can effectively enhance innovative thinking among college students. It provides valuable insights to educators, policymakers, and researchers regarding the efficacy of this Learning as a teaching method(Thomas 2000). This paper aims to establish a

foundation for investigating its potential in fostering innovative thinking. Project-Based Learning improves comprehension, aligning with this paper's focus on fostering innovative thinking(Barak and Dori 2005). The notion that Project-Based Learning is an effective strategy for developing skills and achieving desired learning outcomes(Pawar, Kulkarni et al. 2020). Mihardi further strengthen the argument for using project-based learning to promote innovative thinking within specific disciplines(Mihardi, Harahap et al. 2013). Ling (2021)offers a nuanced understanding of how Project-Based Learning caters to specific needs in fostering innovative thinking(Ling 2021). Guo et al.'s comprehensive overview in 2020 demonstrates how project-based learning impacts student outcomes, including their ability to think innovatively. Project-Based Learning into education while emphasizing its potential for innovation(Cho and Brown 2013). Patange et al.'s study in 2019 highlights interdisciplinary approaches focused on standards-aligned projects as having positive effects on student engagement in STEM fields and potential careers (Patange, Bewoor et al. 2019). The findings and methodologies from these studies contribute to strengthening both the theoretical framework and practical application of this research paper.

2.3 Typical research for Project-Based Learning Models

Many scholars have proposed different Project-Based Learning teaching models for undergraduate students, including Larmer Buck Institute's model and Blumenfeld learning model.

Proposing a general Buck Institute's model Includes 7 steps, 1) design and plan. 2) align to standards. Content standards are used in the creation or adaptation of a project to ensure that key aspects from the content area are included and addressed by the project. 3) build the culture. The teacher fosters student curiosity and autonomy, while also promoting collaboration and emphasizing the importance of producing high-quality work. 4)The teacher collaborates with students to establish activities, tasks, schedules, checkpoints, and deadlines. Additionally, they assist in resource exploration, utilization, as well as guiding students in creating their final product. 5) By providing scaffolding support for student learning during project-based activities, the teacher

utilizes a variety of tools and strategies for support based on students' needs. 6) assess student learning. The teacher utilizes both formative and summative assessments to evaluate students individually as well as in a collaborative setting. Additionally, peer evaluations are conducted. 7) engage and coach, Teachers work alongside students(Larmer, Mergendoller et al. 2015). They recognize the requirements of students and offer them necessary assistance. Additionally, they offer motivation and guidance to students whenever required(Larmer, Mergendoller et al. 2015).

The Project-Based Learning teaching model Project-Based Learning typically involves several steps: 1) defining the purpose 2) researching the topic 3) designing the project 4) beginning the project 5) resolving problems 6) completing the project(Blumenfeld, Soloway et al. 1991). It's important to note that the specific steps may vary depending on the nature of the project and the subject area. Additionally, the role of the tutor or facilitator is to guide and support students throughout these steps, providing feedback and assistance as needed. The entire process aims to be genuine, reflecting real-life production activities and utilizing students' own ideas and approaches to accomplish the given tasks. While the final outcome is the main focus in collaborative Project-Based Learning, it is crucial for the success of this approach that students acquire content knowledge and skills throughout the production process (Donnelly and Fitzmaurice 2005).

How innovative thinking is put into practice. Previous studies have shown support for the utilization of the five-stage Project-Based Learning approach in higher education. Overall findings from this study suggest that implementing the five-stage Project-Based Learning framework can be tailored across various educational programs to foster creative thinking and idea generation among university students (Barak and Yuan 2021).

The Project-Based Learning teaching experiment followed the (Barak and Yuan 2021), (Larmer and Mergendoller 2010) implementation process. The reasons are firstly, it is more operable and more in line with the current problems faced by undergraduates in the teaching process. Secondly, it is in line with the national requirements for higher

education to promote innovative thinking throughout the education of undergraduates to enhance their innovative ability.

Therefore, the Project-Based Learning model in my research consists of five steps, (1) identification of need or problem (2) generation of new ideas (3) development of outcome through new Idea (4) experimentation and implementation of new outcome (5) adoption of new outcome. .

CHAPTER 3
METHODOLOGY

The theme of the study was to develop a Project-Based Learning model to enhancing innovative thinking among undergraduate students. The target population was undergraduate students and the researcher set the following research objectives:

1) To study the definition, and component of innovative thinking of undergraduate students.

2) To develop the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

3) To evaluate the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

In order to achieve these research objectives, the researcher divided the research process into three phases:

Phase 1: Studying the definition, and component of innovative thinking of undergraduate students.

Phase 2: Developing a Project-Based Learning model for enhancing undergraduate students innovative thinking.

Phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

Phase1: Studying the definition, and component of innovative thinking of undergraduate students.

In the first phase of the study, the researchers used the literature review methods, expert interview and questionnaire method, it carried out according to the following steps:

3.1.1 literature review methods----Research related literature

The study was conducted using literature review methods studying the definition, and component of innovative thinking of undergraduate students.

1.The researchers reviewed the literature and research related to innovative thinking. In the international situation, innovative thinking is considered essential to the workforce of the 21st century and is considered a valuable feature of human cognition(Barak and Usher 2019).Only innovative thinking can solve problems and open up new paths(Gao 2021).Today, education faces the need to teach innovative thinking and a systematic approach to problem solving (Barak and Goffer 2002). In China's domestic situation, The Central Committee of the Communist Party of China and the State Council have issued the Outline of the National Strategy for Innovation-Driven Development: promoting innovation in education, reforming the mode of talent cultivation, and integrating the cultivation of the scientific spirit, innovative thinking, creativity, and a sense of social responsibility throughout the entire process of education.

2: Research Constructivism Learning Theory, further study the definition and component of innovative thinking.

3: Through the literature and research related to innovative thinking, the researcher used these data content as a guide to create a Semi-Structured Interview. The interview questions adopted an open form to interview qualified persons of professional education students. (see Appendix A).

3.1.2 Expert interview methods-----Research related expert interview

The researcher defines the purpose and question points (interview topics) of the interview and designs open questions. 5 senior professionals with expertise in psychology, thinking/innovation ability and education were contacted through online,

written and telephone channels, specifically: There are three professors, one an associate professor and one a instructor, In selecting these professionals, the criteria considered include: 1) a degree in education, psychology, educational psychology or a PhD; 2) At least 5 years of teaching experience in a school of General Education, a teacher's college, a school of Psychology or a school related to education. The researcher conducted interviews according to the interview topics and recorded the interview recordings. (Detail see Appendix B)

After obtaining relevant data through semi-structured interviews, it was used to guide the establishment of measurement tools to support innovative thinking.

Data obtained from interviews with five experts were analyzed using content analysis, key issues were summarized in the annex, and these data were used to define innovative thinking and components. (Detail see Appendix C)

3.1.3 Questionnaire methods-----Questionnaire survey on Innovative Thinking of undergraduate Students

In order to improve the practicability and effectiveness of the questionnaire, the researcher asked the sample group to fill in the questionnaire of students' innovative thinking. The detailed information is as follows:

Population

The population used in the study was a sample for the analysis of innovative thinking of undergraduate students. According to the <2022-2023 Yunnan Provincial Education Development Statistics Bulletin> released by the Yunnan Provincial Department of Education in April 2023, there are now 1,616,600 undergraduate students in Yunnan Province.

Sample

In the selection of schools and majors, the researchers used a multi-stage random sampling method. In the first stage, multi-stage random sampling was used to select Kunming City from eight prefecture-level cities and eight autonomous prefectures in Yunnan Province; in the second stage, one university in Yunnan Arts university were extracted from Kunming City using simple random sampling; in the third

stage, 100 students majoring in visual communication design of Yunnan Art University were selected by simple random method.

The research tools used for the study was the questionnaire of students' innovative thinking, which included the following steps:

1: By studying relevant academic literature, books and domestic and foreign studies, the researchers adopted the concept of (Morad, Ragonis et al. 2021) and (Hart 1996), and combined with the interview results of five experts, summarized the definition and components of students innovative thinking, it include Ability to recognize and understand needs on a cognitive level, generation of innovative ideas, transform ideas into concrete outcomes, implementing results based on cognition, added value through cognitive processes.

2 : According to Innovative Thinking Scale' (Barak, Watted et al. 2020)and Conference Board of Canada, 2013, (Test 2000)Formulate 35 questionnaire questions about students innovative thinking, Questions were designed to have an open-ended structure, Likert scale of 1-5 was used,Includes 35 items, consistent with professional terminology and practice definitions, and questions had a 5-level valuation scale, ranging from "Very inappropriate" to "Highly appropriate".(Detail see Appendix D)

TABLE 1 Questionnaire survey on Thinking of undergraduate Students (a part)

Questionnaire on Innovative Thinking of College Students in Yunnan Art University

This survey was conducted anonymously for academic research purposes, with the aim of promoting the innovative thinking ability of college students. Please fill in the questionnaire carefully and truthfully according to the prompts of the questionnaire to provide scientific basis for this study. There is no right or wrong answer to this questionnaire, good or wrong. We will keep all your information confidential. Thank you for your support!

Part 1: General information

1 College major:

2 Grade:

3 Sex:

Part 2:Measurement answer description

Please read and understand the text of each paragraph carefully and mark √ .Only one answer can be selected for each question in this test. Please select the answer that best fits your situation and put a tick on the corresponding number.

1	2	3	4	5
Very inappropriate	Relatively inappropriate	Uncertain	Relatively appropriate	Highly appropriate

Submit the questionnaire of students innovative thinking to 3 experts adjust the item. These 3 experts are lecturers who consider academic qualifications and fields related to students' education. A minimum of 5 years of employment.

4 .Combined with the opinions of three experts, Determine the final questionnaire questions. The researchers adopted the Item objective congruence (IOC) of students 'innovative thinking questionnaire questions was calculated, and the range value was between 0.67 to 1.00, which met the standards of the questions. (Detail see Appendix E)

5.The revised questionnaire of students' innovative thinking will be try-out. Used try- out students who are pursuing a third-year undergraduate degree, the number is 100 students. Cronbach's Alpha coefficient was calculated to evaluate the reliability of the questionnaire. The results showed that the overall reliability of the questionnaire was 0.872. The questionnaire is detailed in Appendix F.

Data collection

The researcher obtained the data collection permission of the sample students by contacting the school of Yunnan Arts University. After obtaining permission, the researcher conducted the data collection through the questionnaire Star.

Data analysis

2.1. Qualitative data analysis: The researchers conducted content analysis through the data obtained by interviewing experts to determine the definition and components of the innovative thinking questionnaire and used it as a guide for the follow-up research tool.

2.2. Quantitative data analysis: researchers conducted basic statistical analysis on quantitative data of the innovative thinking questionnaire and calculated the reliability of the questionnaire.

Phase2: Developing a Project-Based Learning model for enhancing undergraduate students' innovative thinking

This second phase of research covered research objective 2, which was to develop a Project-Based Learning model to improve the innovative thinking of undergraduate students. Therefore, this research phase consists of the following steps:

1. literature review methods-----research related literature

The origin and definition of Project-Based Learning are studied, and the characteristics and construction of this model are clarified. And analyzed this learning in improving the innovative thinking of the literature, clear Project-Based Learning to improve the innovative thinking is worthy of research and in-depth.

In this study, based on the Project-Based Learning model study of (Barak and Yuan 2021) and Larmer (Larmer, Mergendoller et al. 2015)view, combined with the data obtained from the five respondents in the phase 1 study and related literature, the researchers formed the five steps of a Project-Based Learning model for undergraduates in the Chinese environment. It mainly includes:(1) identification of need and problem, (2) generation of new ideas, (3)development of outcome through new

Idea,(4)implementation of new outcome,(5)adoption of new outcome. Taking these elements as the main step process, the researchers designed learning activities to provide practice opportunities for Chinese undergraduates, and students formed a learning atmosphere that supported each other's learning in the practice process of learning. The Project-Based Learning model developed by the researchers consists of 10 lesson learning activity, each of which takes about 90 to 120 minutes. Each lesson is based on the following three steps: import activity, the execution activity, and the summary activity.

2 expert interview methods------expert interview methods

1)The researchers used 3 experts (Appendix A) in a formative way to develop the Project-Based Learning model to improve the innovative thinking of undergraduates. These experts include two professor, one Associate Professor. Considering the opinions and suggestions of the experts, the researchers analyzed the content and the activity execution steps of the Project-Based Learning model to ensure the validity of the content.

3) The researchers analyzed the scores of three experts on the Project-Based Learning model, and evaluated its consistency through the project Goal Consistency (IOC) index, which was between 0.67 and 1.00.

4) The researchers conducted a try-out of the Project-Based Learning model adjusted by expert advice, and this model was applied to the teaching activities of 10 undergraduates students from Yunnan Arts University,The 10 students are all from the art design major, they have the same academic background, and belong to the same grade.

Phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

In the third phase of the study, the researchers will focus on the impact of the Project-Based Learning model on undergraduate students to improve undergraduate students innovative thinking. The study utilized a Quasi-Experiment (QE) design that included experimental and control groups using a two-group research design and a pre and post-test (Control Group Pre-test, Post-test Design). This is a widely used experimental design that helps to assess the effectiveness of a learning model. The experiment was designed as follows.

3.3.1 Research design

The quasi-experimental design that included an experimental and control group. The "R" next to each group (E and C) stands for "Random Assignment". Random assignment is a critical methodological step in experimental research. It involves randomly assigning participants to different experimental conditions or groups. The purpose of random assignment is to help ensure that the experimental and control groups are equivalent on all relevant variables at the beginning of the study. This is shown in the figure below:

TABLE 2 Repeated Measures Design

Group	Pre-test	Treatment	Post-test	Follow up
E R	T1	X	T2	T3
C R	T1		T2	T3

The meaning of the symbols is as follows:

E Experiment group

C Control group

R Random assignment

T1 Pre-test

T2 Post-test

T3 Follow up

X Treatment. Strategically designed using a Project-Based Learning model designed to enhance innovative thinking.

3.3.2 Population and sample

Population: This population was used to evaluate trials using Project-Based Learning models to improve innovative thinking among undergraduate students. The students were in the third year of an undergraduate degree programme. The main study major is art design from Yunnan Arts University, with a total of 100 students.

Sample: This sample was used to evaluate the use of this Learning models to improve innovative thinking of undergraduate students. The students were in the third year of an undergraduate degree programme. The main study major is art design from Yunnan Arts University. This sample group had 50 students, who were selected through random assignment, and who volunteered to participate in the trial. They were divided into experimental group and control group with 25 people in each group.

3.3.3 Experiment implementing

The researchers conducted the experiment according to the above experimental plan, which was divided into four stages, as follows:

3.3.3.1 Pre - test

Before the experiment starts, randomly assign participants to the experimental group (E) and control group (C). Researcher the pre-test to assess the level of innovative thinking in the experimental group (ER)and control group (CR). The researcher then arranged a meeting to elaborate the details of participating in the 10 learning activities to the sample group.

3.3.3.2Treatment

The researcher conducted the experimental treatment and implemented the Project-Based Learning model for the experimental group (E). Ensure that treatment (X) is standardized and delivered consistently to all participants in the experimental group. According to the prescribed schedule, combined with the teaching material "Intangible Cultural Heritage Creative Design Courses ", the Project-Based Learning model that has passed the quality inspection and test was applied to the experimental

group for 10 times, each time 90-120 minutes, lasting 5 weeks, and was carried out in Room 301 on the third floor of the School of Design. The control group (C) did not receive the Project-Based Learning model treatment during this phase. They can continue to use traditional teaching methods. Project-Based Learning model Lesson plan is shown in the following table.

TABLE 3 Project-Based Learning model Lesson plan

Time	Time of week	Lesson plan
1	Week 1	The orientation of students' innovative thinking
2	Week 1	Identification of need and problem ------observe the phenomenon of batik creative design
3	Week 2	Identification of need and problem------ identifying batik travel products problems
4	Week 2	Generate new ideas------story generation of new ideas
5	Week 3	Generate new ideas------ SCAMPER link idea matching
6	Week 3	Development of outcome through new Idea------ role-playing.
7	Week 4	Development of outcome through new Idea------ generate iterations through training plan projects
8	Week 4	Implement results------use display to test the implementation of new outcome
9	Week 5	Realize added value------adoption of new outcome
10	Week 5	Review and reflection

3.3.3.3 post-test

After the completion of the Project-Based Learning model treatment, researcher the post-test to measure innovative thinking in the experimental group (ER). Assess the immediate impact of the Project-Based Learning model. Researcher the post-test to measure innovative thinking in the control group (CR). Establish the baseline for comparison with the experimental group.

3.3.3.4 Follow up

After 4 weeks, conduct a follow-up assessment of innovative thinking in the experimental group (ER) and control group (CR) by administering the follow-up test.

3.3.4 Data analysis

Researchers use quantitative analysis methods to process data and conduct data analysis to answer the research purpose, which specifically includes:

Perform preliminary data analysis through basic statistical analyses such as means, standard deviations, and differences between means.

(2) Analysis of ANOVA was used to compare the mean value of innovative thinking between the experimental and control groups before and after the trial, and at the end of the follow-up period.

CHAPTER 4
RESEARCH RESULTS

The purpose of "A Development of The Project-Based Learning Model for Enhancing Innovative Thinking of Undergraduate Students" is to study the definition and component of innovative thinking of undergraduates, and to provide a basis for the development and evaluation of experiments using Project-Based Learning model to promote innovative thinking of undergraduates. To ensure comprehension and interpretation, the notation and abbreviations used in the data analysis were formulated and the data analysis results were presented in the following order.

Symbol and abbreviation of data analysis as follows:

- n: the number of participants in the sample
- M: the mean
- MD: the mean difference
- S.D: the standard deviation
- p: the statistical significance level
- t: t-test
- ss: sums of squares
- df: degrees of freedom
- MS: Mean squares
- CCIN: Cognitive competency to identify needs.
- CCGNI: Cognitive competency to generate new ideas
- CCCIFO: Cognitive competency to change ideas to formulate outcomes
- CEIR: Cognitive competency to implement results
- CCRAV: Cognitive competency to realize added value.

Present data analysis results. In this study, the researchers presented three data analysis chapters. The details are as follows:

Phase 1: Studying the definition, and component of innovative thinking of undergraduate students.

Phase 2: Developing a Project-Based Learning model for enhancing undergraduate students' innovative thinking

Phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

Phase1: Studying the definition, and component of innovative thinking of undergraduate students.

4.1.1 Definition of innovative thinking

4.1.1.1 The definition of innovative thinking is obtained through literature review. After reviewing the literature, the researchers found that there are several views on the definition of innovative thinking. Through (Hart 1996)and (Morad, Ragonis et al. 2021) Innovative thinking interview, it was found that the interviewed experts all agreed with the view, which refers to Innovative thinking is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value.

4.1.1.2 The definition of innovative thinking was obtained through expert interviews.

The researchers interviewed five experts on the definition of innovative thinking, as follows: Experts 1 believe that “innovative thinking requires a certain cognitive ability to think and recognize effectively in learning activities. Being able to effectively define a problem means understanding the nature and key points of the problem. Generating new ideas and putting them into practice is a core part of innovative thinking. The value of innovation comes from being able to effectively implement innovative ideas with meaningful results. From cognitive ability to problem

definition, pertaining to the creation and utilization of novel concepts, and finally the realization of innovative value." (Experts 1)

Experts 2 point "the definition of innovative thinking for undergraduate students in China is the abilities to adapt and creative problem-solving in the rapidly changing society." (Experts 2)

Expert 3 added his views the meaning of innovative thinking was "the process of understanding a phenomenon or problem from different aspects and different perspectives, rejecting the habitual mainstream understanding, treating a problem critically and questioning, and finally solving the problem." (Experts 3)

Summary, the experts collectively agreed that the definition of innovative thinking should include learning activities, can defining the problem ability, have generating new or improved idea ability, and can made the results of innovative value it can be use it in real life.

4.1.1.3 The definition of innovative thinking was obtained through literature review and expert interviews.

Researchers integrated the ideas of (Hart 1996) and (Morad, Ragonis et al. 2021), combined with interviews with interviewees, and summarized the definition of innovative thinking through literature review and expert interviews as follows:

Innovative thinking for undergraduate students is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value.

4.1.2 Components of innovative thinking

4.1.2.1 The components of innovative thinking is obtained through literature. After the researchers cited past literature, there are five components of innovative thinking from Morad indicate that innovative thinking components. The review shows that the researchers used the 5 components of innovative thinking by Morad as the main framework for this study. It follows as that:

Components 1 Cognitive competency to identify needs. Refers to students' ability to effectively identify or articulate a requirement or an issue. Students have the observation power to identify needs, understand problems or goals in daily life situations, and thus can accurately and effectively define needs and express ideas.

Components 2 Cognitive competency to generate new ideas. Refers to students having an individual's ability to create fresh, innovative, or modified concepts and thoughts. Ability to think creatively, connect unrelated concepts and explore new ideas.

Components 3 Cognitive competency to change ideas to formulate outcomes. Refers to a student's ability to link newly generated or modified ideas to actual generation. By linking new or revised ideas to real problems to generate effective responses and contribute to achieving results through actions, planning, and organizing resources.

Components 4 Cognitive competency to implement results. Refers to a student's ability to successfully iterate and apply new or improved results from experiments. It can successfully apply new or improved experimental results in a specific group or unit, market, or organization, and have a positive impact.

Components 5 Cognitive competency to realize added value. Refers to a student's ability to accept and utilize new or improved results or solutions that provide additional benefits or advantages. can be able to recognize the added value of the improved results of new ideas and use their added benefits to achieve more fission capabilities

4.1.2.2 The components of innovative thinking were obtained through expert interviews

Experts agreed on the components of innovative thinking.

Components 1. "Effective identification and observation means that an individual or team can capture problems, needs or opportunities with a keen vision and comprehensive perspective, and conduct in-depth and systematic analysis and

understanding of them, which is also the most basic and critical first step of innovative thinking" (Expert 4).

Components 2. "Creativity is an important basis for innovation. Considering the current situation of Chinese undergraduates, it is an important link for students to stimulate new ideas and new perspectives, break traditional thinking patterns and connect unrelated concepts to expand the breadth and depth of thinking" (Expert 5).

Components 3. "At present, Chinese students lack the necessary ability to relate new or modified ideas to actual production. This is a very important step in connecting with society and can facilitate the formation of results" (Expert 3).

Components 4. "Within the current student's applied competence, students need to be strengthened and equipped with the ability to improve results. And students should be able to solve problems. In general, students can achieve this ability through relevant learning strategies and methods, which is an indispensable ability for innovation. It is also an effective proof of whether students have this ability" (Expert 3).

Components 5. "It provides the essential skills in today's fast-changing world. such as continuous learning, digital literacy, growth mindsets, ethical standard and culture diversity are also important components" (Expert 3).

The components of innovative thinking were obtained through literature review and expert interviews.

Summary, Researchers integrated the ideas of(Morad, Ragonis et al. 2021), combined with interviews with expert, and summarized the components of innovative thinking through literature review and expert interviews as follows composed of the following five components:1) Cognitive competency to identify needs.2) Cognitive competency to generate new ideas. 3) Cognitive competency to change ideas to formulate outcomes. 4) Cognitive competency to implement results. 5) Cognitive competency to realize added value.

Phase 2: Developing a Project-Based Learning model for enhancing undergraduate students' innovative thinking

In the first part, the concept of Project-Based Learning model is developed.

First, researchers clarified the definition and components of innovative thinking. In the first phase of the study, researchers studied literature and research books related to innovative thinking. Thus, researchers will cite Morad five components of innovative thinking.

Secondly, to enhance students' innovative thinking, researchers have proposed a variety of methods, such as training, practical activities and the use of various learning modes. Researchers have developed a planned, Learning model and teaching activities. These activities are designed to allow undergraduate students to gain relevant competencies from the corresponding activities. While enhancing their innovative thinking by planning and executing diverse activities. This helps to cultivate the innovative thinking of undergraduates.

In this study, researchers based on and integrated the research of (Barak and Yuan 2021) and (Larmer and Mergendoller 2010)on this model as a method to enhance students' innovative thinking. According to this theoretical model, he suggested using Buck Institute's Project-Based Learning general model to enhance students' innovative thinking. According to the theoretical framework proposed by (Barak and Yuan 2021), it has been emphasized that studies focusing on higher-order thinking skills highlight the significance of fostering innovative thinking through the implementation of Project-Based Learning (PBL). Additionally, their research introduces a five-stage process for cultivating innovation through PBL, which can be effectively incorporated into higher education curricula.

The findings indicated that students who participated in activities based on Project-Based Learning exhibited notable enhancements in a range of 21st-century competencies, encompassing creativity, communication, self-evaluation, collaborative participation, skills in guiding a team, and analytical reasoning. The utilization of Project-Based Learning emerged as an efficacious approach for nurturing these fundamental

skills. It is evident that Project-Based Learning holds substantial value as a pedagogical strategy for enhancing both sets of proficiencies.

In addition, the researchers also interviewed five experts, in the first stage of the study, after interviews with professionals, their views are consistent and summarized as follows:

1.“Project-Based Learning model”: Project-Based Learning model is an open-ended inquiry-based approach to teaching and learning. It enables students to have the observational skills to identify problems based on the real-world problems and tasks provided, the creativity to stimulate new ideas, the linking ability to use innovative tools for continuous inquiry, the cognitive ability to realize their self-worth and the social added value of their products through the formation of effective product development with the ability to iterate and implement the product results into a product.

2.The Project-Based Learning model in the context of China, the activities used to promote students' innovative thinking should include five steps, which are:(1) identification of need and problem. (2) generation of new ideas. (3) development of outcome through new Idea. (4) implementation of new outcome (5) adoption of new outcome. These are consistent with the steps of Project-Based Learning pointed out by(Larmer and Mergendoller 2010)and the Project-Based Learning model produced under the Chinese background, and are also the main concepts adopted by researchers when designing learning activities and Project-Based Learning models. Based on relevant literature and research, as well as qualified interview data, the steps to implement the project-based learning model in a Chinese social context include (1) Identification of need and problem. (2) Generation of new ideas. (3) Development of outcome through new Idea. (4) Implementation of new outcome (5) Adoption of new outcome.

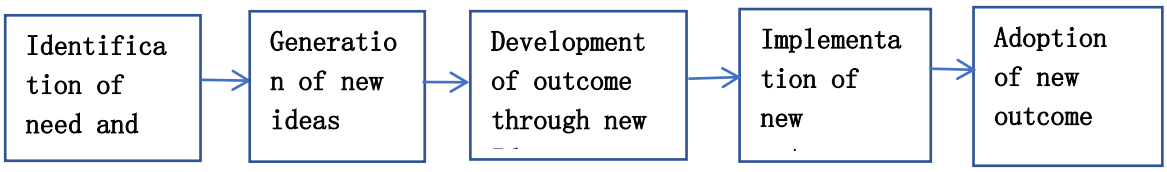

FIGURE 5 Project-Based Learning model

In the second part, the Project-Based Learning model is developed to improve the innovative thinking of undergraduates.

In the process of promoting innovative thinking, researchers have used the Project-Based Learning model theory of (Barak and Yuan 2021) and (Larmer and Mergendoller 2010), authoritative interviews with experts as a guide for designing learning activities. Through learning activities, teachers can train students' 5 kinds of innovative thinking: Identification of need and problem, generate new ideas, change ideas to formulate outcomes, implement results, realize added value.

(1) The purpose of developing the Project-Based Learning model

In this study, the Project-Based Learning model is a learning activity developed to improve students' innovative thinking. Its purpose is as follows:

Identification of need and problem: The aim is to enable students to effectively identify or express needs or problems. Through this step, students will learn to observe and analyze the needs and problems in real life, so as to develop the awareness and ability to solve problems.

Generate new ideas:The aim is to equip students with the ability to create new, innovative or improved concepts and ideas. This step encourages students to think creatively, connect different ideas and concepts, and explore new solutions.

Change Ideas to Formulate Outcomes:The aim is for students to be able to relate newly generated or improved ideas to actual situations. Through this step, students will learn to translate theory into practical and feasible solutions and formulate effective outcomes for problem solving.

Implement results:The aim is to enable students to successfully apply new or improved results to practice. This step encourages students to perform practical

operations, validate their ideas and results, and gain experience and feedback from them.

Realize added value: The aim is for students to recognize the added value of new or improved results. Through this step, students will learn to evaluate and embody the value of innovative results, thus providing more inspiration and direction for future innovation and development. Combined with the teaching material "Intangible Cultural Heritage Creative Design Courses "as a third-year undergraduate course of art and design in Yunnan Arts University, the teacher designed 10 learning plans.

(2) The learning activity form of the Project-Based Learning model has three steps, and the specific activity process is as follows:

2.1 Activity intervention phase: Researchers explained the goal, established relationships, and introduced the concept and significance of innova tive thinking to students. The Project-Based Learning model and curriculum planning are elaborated to help students establish a sense of learning.

2.2 Activity implementation stage: This stage officially enters the stage of training students' innovative thinking, and students are trained through various learning forms and strategies.The specific implementation steps include five aspects:

2.2.1 Identification of need and problem: This refers to clarifying the goals and objectives of the project and understanding the requirements and problems faced. It involves research, problem analysis, market research, etc., to ensure that the project fundamentally solves a real need or problem.

2.2.2 Generate new ideas: Refers to the need for individuals or teams to generate innovative ideas and solutions based on an understanding of requirements and problems. This phase is about creative thinking, brainstorming and exploring the possibilities to find the most suitable scheme.

2.2.3 Change ideas to formulate outcomes: This is when individuals or teams need to flesh out ideas and create action plans and project plans. Include e specific project plans, design schemes, etc.

2.2.4 Implement results: Refers to the phase of putting the plan into practice, executing the project and producing results. Through the display, resource allocation, test form.

2.2.5 Realize added value: It refers to evaluating the results of the project and determining the added value or additional benefits of the project and obtaining additional social value or derived value through the project.

2.3 In the summary stage, researchers invited students to participate in each activity and conduct return visits and discussions to achieve the aim of improving innovative thinking.

(3) The content of learning activities of Project-Based Learning model.

In this study, Innovative thinking is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value. Therefore, the learning activities of the Project-Based Learning model mainly include the following steps.1) Identification of need and problem. 2)Generation of new ideas. 3)Development of outcome through new Idea. 4)Implementation of new outcome. 5)Adoption of new outcome.

(4) Experiment period

The project-based learning model includes 10 lesson learning plans, lasting 5 weeks, each of which lasts 90-120 minutes, and is carried out in the Course of Intangible Cultural Heritage Creative Design Courses.

(5) Principles for carrying out activities

The learning activities of this study were organized according to the following principles:(1) Relevant social practice opportunities were provided to undergraduates. (2) It provides students with the ability to realize innovation based on professional and social practice, and improves their research ability and observation ability. (3) It provides students with opportunities to exercise their thinking and connect with the society. (4) Encourage students to think positively and stimulate their potential.

(5) Students learn how to help each other and cooperate to achieve the landing of the project. Provide positive feedback to foster creative thinking.

(6) The role of the researcher

First, researchers need to :(1) understand and study the Project-Based Learning model in detail. (2) make relevant preparations before proceeding to the Project-Based Learning model (3) be able to form good interaction and cooperation with students. And guide students to complete the learning process through the teaching strategy of observation, excitation, link and iteration. (4) Students need to pay close attention to their learning process and behaviors.

(7) The role of the subject of study

The roles of undergraduate students involved in learning activities are as follows:(1) being allowed to express their own views and be able to respect the opinions of other members (2) being able to actively participate in and contribute to discussions during learning activities and provide corresponding feedback. (3) They can exert their imagination and innovation to improve and consciously implement the protocols and procedures of each activity with the help of learning strategies. (4) Undergraduates can record and feedback the results of participating in each learning activity after completion.

Based on the above studies, researchers have proposed a Project-Based Learning model to improve the innovative thinking of undergraduates. Here's how the researchers explained the steps of the learning plan:

1)The orientation of students' innovative thinking introduction

In order to establish a friendly atmosphere between the researcher and the students, the researcher explained to the students the purpose of the study plan, the teaching details and the process, including the benefits that the students would get from participating in all the activities. This will help students to better know and understand the activities that will be involved.

2) Identification of need and problem -------Observe the phenomenon of batik creative design

Indeed, great innovators are great observers(Ness 2015). Observation is an innovative ability that must be cultivated. Observation is the act of intently and intentionally noticing and gathering information from the surrounding environment, experience, or existing systems. In this study, Observation is essential for generating new ideas, identifying problems or opportunities, and understanding user needs. Observation attention to patterns and trends, identify problems and opportunities. gain insight and inspiration. Observation can keep us curious, open, and attentive to the world around us, constantly seeking understanding, and learning from our observations to drive meaningful innovative thinking.

3) Identification of need and problem -------identifying batik travel products Problems

Identification is a crucial role in the innovation process as it involves individuals or teams actively striving to comprehend and elucidate the circumstances that necessitate innovation. Innovative thinking involves keenly observing the world and identifying areas where there are unmet needs, inefficiencies, or challenges. This awareness often stems from observing the gap between existing solutions and expected results or experience. Identification involves defining problems or opportunities in a way that stimulates creative thinking and ideation. The ability to identify effectively is the foundation of innovative thinking, as it lays the foundation for generating creative solutions and driving meaningful change. Gain effective recognition by experiencing strategies in real life scenarios. The core of the procedure lies in the detection and acknowledgment of possibilities – a portion of which will inherently be unique, and numerous opportunities may necessitate innovative approaches for their utilization(Chell and Athayde 2009).

4) Generate new ideas-------Story generation of new ideas

We found that stories communicate vivid im- ages of most important beliefs. Utilizing storytelling as a powerful tool, one can effectively express this

vision and consistently adapt these narratives to provide novel perspectives and reveal undiscovered obstacles. Stories have an extraordinary capacity to stimulate creativity, to stimulate our imagination, emotions, and intelligence in ways that transcend facts or information. Stories inspire creativity by engaging our emotions, stimulating our imagination, challenging our assumptions, and fostering empathy and understanding. By immersing ourselves in rich narratives, we can unlock new perspectives, envision innovative solutions, and harness the power of storytelling to drive positive change and transformation.

5) Generate new ideas-------Story generation of new ideas

The concept of linking plays a vital role in connecting the different elements of the innovation process. The ability to make connections, relationships, or associations between different ideas, concepts, or information. SCAMPER, an innovative thinking training tool, facilitates the process of ideation and elaboration. When students generate ideas using SCAMPER prompts, they have the opportunity to test, iterate, and refine their concepts based on feedback and insights gained along the way. This linking approach enables students to continually improve their ideas and develop more innovative solutions over time.

6) Development of outcome through new Idea-------Role-playing.

Innovation is seen as an ongoing process rather than a one-off event. That is, the innovator must go through the process of critical thinking to produce iterative effects that promote the generation of results. Students are asked to think creatively and critically. They are required to demonstrate innovative analysis and synthesis of content. Accomplishing these tasks necessitates a comprehensive comprehension of the demanding course material as well as proficiency in linguistic and cognitive abilities. Across the college curriculum, role-play is being used to facilitate a deeper and more critical understanding of course material(Shapiro and Leopold 2012). In the mid-1980s, the educational approach of role-playing had expanded to encompass a wide range of activities, ranging from brief icebreaker games to elaborate assignments that demanded several weeks of advance planning(Ladousse 1987).

Similar to any educational approach, role-play has the potential to be utilized without careful consideration, leading to a shift in emphasis from learning to mere amusement (Shapiro and Leopold 2012). At the same time, in this process, it can also promote students to accept subject skills and improve students' professional ability. The role play method fully establishes the subject status of students and can also make students more confident in the actual work in the future.

7) Development of outcome through new Idea-------Generate iterations through training plan projects

According to (Smith and Eppinger 1997), having a deep understanding of iteration is crucial for enhancing and expediting the process of product development, as well as for projects in various other fields. Iteration is an inevitable aspect of any project (Mihm, Loch et al. 2003, Braha and Bar-Yam 2007). The importance of iteration is widely recognized in various fields such as design, product development, software engineering, construction, and other related disciplines. According to experts in the field, it has been suggested by practitioners and academics that the design process is considered to be highly characterized by its "iterative" nature (Maier and Störrle 2011). Consequently, design, development, and various other undertakings invariably encompass the process of iteration. Iteration yields favorable outcomes by facilitating the gradual accumulation of knowledge, enabling simultaneous progress, and seamlessly incorporating essential modifications. Hence, in practical scenarios, the concept of iteration holds significant importance. Iteration encompasses not only the design development but also includes aspects such as monitoring, self-evaluation, and control over the design process (Adams and Atman 2000). In this activity design, the researchers focused on the process of design and problem solving, showing the iteration between the basic activity types. This iteration is manifested in the macro level by guiding the writing of the innovation and entrepreneurship training plan for college students, formulating specific plans, clarifying the goals, tasks, deliverables and budget of each iteration cycle. Iteration planning allows the team to keep the project organized and ensure that it produces valuable outputs. Combined with the actual situation of Chinese universities, this method can effectively improve the success rate and innovation of the project.

8) Implement results-------Use display to test the implementation of new outcome

Innovative thinking involves not only generating creative ideas, but also implementing those ideas effectively to bring about tangible results or solutions. The concept of implementation in innovative thinking refers to the process of translating innovative ideas into practical actions, strategies, products or services to meet an identified need or opportunity. Here's how I understand implementation in the context of innovative thinking: First, actionable planning: Implementation involves developing an actionable plan or strategy to turn an innovative idea into reality. And provide students with a physical form to express ideas in a presentation. Students present their projects in a commercially attractive way by participating in events. This activity will take place in outdoor public Spaces or other platforms such as exhibition halls.

9) Realize added value------- Adoption of new outcome

In the context of innovative thinking, the concept of adoption refers to the process by which an individual, organization, or society accepts an innovative idea, practice, technology, or solution and integrates it into everyday life, processes, or behaviors. By understanding the factors that influence the adoption and implementation of strategies to foster acceptance and integration, innovators can maximize the likelihood of widespread adoption and the full potential of their innovations. Through whether the work is applied for copyright or patent, to achieve the acceptance and recognition of innovative products.

10) Review and reflection

The training terminates with the formation of students' innovative thinking. Opportunities are provided for students to reflect, reflect and summarize. This stage of review and reflection is a critical moment for students to internalize what they have learned, assess their progress, and identify key points from the entire creative thinking process. Innovative thinking is an indispensable core ability in students' study and life. The 5 major steps of a Project-Based Learning model that will observe, generate ideas, experiment and implement, adopt a facilitating process. Engaging in

reflective learning can consolidate students' understanding of the concepts covered and consider how they can be applied to their applicability in future endeavors. This process ensures that innovative thinking is not just an abstract skill, but a practical tool that students can apply in the real world, thereby contributing to their continued growth and development.

Time	Time of week	Learning Activity	Objective	Technique /Strategy
1	Week 1	The orientation of students' innovative thinking	1. To Introduce the concept and significance of students' innovative thinking. 2. To Introduce project-based learning model and course planning.	Video resources introduce
2	Week 1	Identification of need and problem ------ observe the phenomenon of batik creative design	1.To stimulate students' interest and background knowledge. 2.Cultivate students' observation consciousness, and have the ability of observation and discovery through experience learning 3. Can understand and clearly describe the production process of batik can be implemented.	Observe the phenomenon of batik creative design
3	Week 2	Identification of need and problem------- identifying batik travel products problems	1. By effectively identifying problems that can understand and clearly describe products in specific situations, accurately sketch and analyze human product portraits and stakeholders according to project phenomena, and locate demand objects. 2. To trained students recognize the observed phenomenon and bring it to the real environment, and form a consciousness and cognitive sensitivity of the problem to be solved, and have the awareness of exploring multiple angles and alternative angles. 3.To develop students' practical problem-solving skills and a deep understanding of cultural products and their markets.	Identifying batik travel products Problems

4	Week 2	Generate new ideas------ story generation of new ideas	To help students carry out imaginative and innovative design creation according to the identified problems, stories are used to stimulate imagination and improve personal creative thinking ability. 2. To enhance students personal expression ability, empathy and understanding. Stories provide a platform for personal expression and self-discovery, enabling individuals to share their unique voices, experiences, and insights with others. 3. To develop a sense of community and connection. Stories have the power to build Bridges between people, create connections, and foster a sense of belonging in communities	Storytelling
5	Week 3	Generate new ideas-------- SCAMPER link idea matching	1.Stimulate creative thinking and innovation by using SCAMPER to enable students to systematically link insights, viewpoints, ideas, perspectives and technologies from different fields. Through the application of SCAMPER tips (replace, combine, adapt, modify, reuse, eliminate, reverse), students will develop creative problem solving, innovative thinking, and interdisciplinary collaboration.	SCAMPER Link idea matching
6	Week 3	Development of outcome through new Idea---- role-playing.	1.Students will demonstrate their ability in the design process of batik products, rehearse their ideas and refine the gap and contradiction between the actual results through role play. 2.To develop students' basic skills in problem solving, communication and teamwork in simulated realistic scenarios by engaging in role-playing activities. 3. Let students have a deeper and thorough understanding of the complexity of batik product design and cultivate their innovation ability and adaptability to dynamic innovation synthesis.	Role-playing

7	Week 4	Development of outcome through new Idea---- generate iterations through training plan projects	1. To training students' ability of reflection and improvement using iterative method in the process of project development through guiding and participating in the innovation and entrepreneurship training program for college students. 2. The practical operation of students is emphasized through the activity design. Students can gain practical experience through the writing and mutual evaluation of real project books.	College students' innovation and entrepreneurship training program project book training
8	Week 4	Implement results-----use display to test the Implementation of new outcome	1.Students are able to develop the ability to demonstrate innovative products to the real world through collaboration with external stakeholders and develop commercial attractiveness. 2. To help students develop actionable abilities to bridge ideas and influence and translate creative visions into practical outcomes. 3.To enhance their collaboration skills and understanding of the practical application of academic knowledge.	Use display to test the implementation of new outcome
9	Week 5	Realize added value--- adoption of new outcome	1.To help students build awareness within the broader context of innovative thinking and innovative ideas, practices, technologies or solutions to ensure that this novelty is widely accepted and integrated into everyday life, processes or behavior. 2. To enhance students' legal awareness to clearly establish the ownership and originality of innovation. This legal recognition helps build trust among users, stakeholders and potential investors, making it easier for them to accept innovative solutions and integrate them into processes or products. 3.Students possess quality and authenticity that can be used in different contexts. Copyright protection helps maintain the integrity of the work, ensuring that any adaptation or modification remains true to the	The acquisition of copyright or patent for the work

			original vision and purpose of the innovation.	
10	Week 5	Review and reflection	1. To develop self-awareness through reflective learning that encourages students to reflect on their experiences, challenges, and growth throughout the lesson plan. 2. To provide structured opportunities for students to consolidate their understanding of innovative thinking concepts and their application to real-world Settings through project-based learning models. 3. To guide students to identify and articulate the most important lessons and insights gained from the entire learning process.	Interview record

FIGURE 6 Teaching implementation plan

Phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

This paper describes the evaluation of an experiment based on Project-Based Learning model, including implementation and result analysis of the experiment.

In the experimental evaluation, the researchers set two hypotheses.

1 Undergraduate student's innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than before beginning the experiment.

2 Undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than those in the control group.

At the end of the experiment, their innovative thinking increased compared with that before the experiment.

In view of hypothesis one undergraduate student's innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than before beginning the experiment. The researchers divided 25 undergraduates into group and the results are shown in table.

TABLE 4 Pre-test and post-test -follow up of innovative thinking

Experimental group	M	S.D.
Pre - test	83.40	28.178
Post-test	119.48	12.933
Follow up- test	139.00	15.457

At the end of the experiment, their innovative thinking increased compared with that before the experiment. The researchers calculated the mean Innovative thinking scores for the experimental group pretest, posttest, and follow up of the experimental tracking (n = 25).

It can be seen from the table that the innovative thinking scores of students in the experimental group were at a high level in the pre-test stage (M =83.40, S.D. =28.178), and reached the highest level in the post-test stage (M =119.48, S.D. = 12.933). It also reached the highest level in the follow up phase (M = 139.00, S.D. = 15.457).

Subsequently, the researchers performed an ANOVA on the experimental groups pre-test, post-test, and at the end of the follow-up.

TABLE 5 Experimental group pre-test and post-test, follow up ANOVA

Innovative thinking	pre-test (*n*=25)		post-test (*n*=25)		Follow up(*n*=25)		*F*□	*p*□
	Mean	Sd	Mean	Sd	Mean	Sd		
CCIN	2.30	1.11	3.33	0.68	3.93	0.96	19.487	0.001**
CCGNI	2.43	1.10	3.43	0.72	4.02	0.64	22.318	0.001**
CCCIFO	2.41	1.11	3.35	0.67	3.85	0.59	19.586	0.001**
CCIR	2.23	0.95	3.35	0.65	3.83	0.41	33.471	0.001**
CCRAV	2.53	1.11	3.61	0.40	4.22	0.41	35.296	0.001**

* $p<0.05$ ** $p<0.01$

As you can see from the table above, ANOVA was used to study the five main components of innovative thinking: component 1 (CCIN) 2: component 2 (CCGNI) component 3 (CCCIFO), component 4 (CCIR), component 5 (CCRAV)a total of 5 differences. It can be seen from the above table that all the five main dimensions are significant ($p<0.05$), It means that different groups of samples have different value.

Specific analysis showed that the component 1 showed 0.01 level significance ($F=19.487$, $p=0.001$). The component 2 (CCGNI) showed a significant level of 0.01 ($F=22.318$, $p=0.001$). For the component 3 (CCCIFO) the group showed 0.01 level significance ($F=19.586$, $p=0.001$). Group for component 4(CEIR) at the level of 0.01 ($F=33.471$, $p=0.001$), and at the level of 0.01 ($F=35.296$, $p=0.001$) for the component 5 (CCRAV).

TABLE 6 Experimental group ANOVA intermediate process values

Experimental group ANOVA intermediate process values

Innovative thinking	Variation	SS	df	MS	*F*	*p*	*(Partial η 2)*
CCIN	Between-group Variation	33.918	2	16.959	19.487	0	0.351
	Within-group Variation	62.66	72	0.87			
	Total variation	96.578	74				
CCGNI	Between-group Variation	32.004	2	16.002	22.318	0	0.383
	Within-group Variation	51.624	72	0.717			
	Total variation	83.628	74				
CCCIFO	Between-group Variation	26.521	2	13.261	19.586	0	0.352
	Within-group Variation	48.748	72	0.677			
	Total variation	75.269	74				
CCIR	Between-group Variation	33.509	2	16.755	33.471	0	0.482
	Within-group Variation	36.041	72	0.501			
	Total variation	69.55	74				
CCRAV	Between-group Variation	36.413	2	18.207	35.296	0	0.495
	Within-group Variation	37.14	72	0.516			
	Total variation	73.553	74				

This conclusion proves the statistical significance of hypothesis one that students who accept the Project-Based Learning model have stronger innovative thinking after the experiment, as well as the conclusion that their innovative thinking increases at the end of the experimental tracking compared with that before the experiment.

In **view of hypothesis two, undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than those in the control group.**

For the experimental results of the control group, the researchers performed ANOVA on the control group pre-test, post-test, Follow up.

FIGURE 7 Control group pre-test and post- test, follow up.

ANOVA

	pre-test (*n*=25)		post-test (*n*=25)		Follow up(*n*=25)		*F*	*p*
Innovative thinking	Mean	Sd	Mean	Sd	Mean	Sd		
CCIN	2.36	1.07	2.27	1.0	2.34	1.13	0.042	0.958
CCGNI	2.14	1.00	2.34	1.03	2.43	1.08	0.536	0.587
CCCIFO	2.06	0.81	2.34	1.07	2.05	0.81	0.846	0.433
CCIR	2.15	1.00	2.19	0.96	2.27	1.05	0.093	0.912
CCRAV	2.38	1.11	2.22	1.09	2.26	1.08	0.156	0.855

It can be seen from the above table, component 1 (CCIN), component 2 (CCGNI). component 3 (CCCIFO), component 4 (CCIR), dimension component 5 (CCRAV)none of them were significant ($p>0.05$). It means that the samples of different groups will not show significant differences. undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than those in the control group.

At the end of the experimental follow-up, their innovative thinking increased compared to before the experiment. The researchers obtained feedback by collecting examples of the opinions of participating students in learning activities. A sample of student feedback is shown in the table below.

FIGURE 8 Sample opinions from students participating in learning activities each time (opinions recorded from study notes/activity records)

Teaching Activities	What you have learned and applied
Cognitive competency to identify needs	1. I have learned how to analyze and evaluate the surrounding environment or the needs of others and understand the nature and influencing factors of problems. 2. Be able to apply relevant knowledge of requirements identification and learn to find methods and ways to define problems. 3. In daily life, I have improved my ability of self-discovery, self-search, self-observation, and self-exploration.
Cognitive competency to generate new ideas	1. Find myself can thinking about problems in non-traditional ways and coming up with unique, creative solutions. 2. In the creative process, I find myself able to connect the connections and associations between different fields and different concepts to generate new combinations and ideas. 3. In the process of creation, I can adjust my thinking mode and method flexibly and adapt to different situations and needs, so as to generate new ideas. 4. I began to be able to effectively express and present my own ideas, including images, words, presentations etc., and often felt that I had a flash of inspiration and creativity. 5. To be exhausted and face the same design concept, I can stimulate my sense of innovation.

FIGURE 8 (Continue)

Teaching Activities	What you have learned and applied
Cognitive competency to change ideas to formulate outcomes	1. During the study, I can consciously develop creative thinking, put forward novel and unique ideas, and transform them into feasible solutions or innovative products. 2. Start to learn how to effectively execute the plan, improve initiative, take the initiative to coordinate resources, manage time, monitor the progress of the project, and ensure the final success of the results. 3. I can make logical reasoning and evaluate the pros and cons of different solutions. 4. I can effectively communicate and cooperate with others and show my ideas in various ways.
Cognitive competency to implement results	1: Find yourself not afraid to make and execute the implementation plan, but willing to try. 2. I am able to promote the implementation of projects or tasks with team members in teamwork and understand the process of project implementation. 3. Learn how to seek resources, maintain effective communication with relevant parties, coordinate resources and stakeholders, and ensure the smooth implementation process.
Cognitive competency to realize added value	1. I will find ways to achieve and improve my ability to expand my products. You learn to think openly about problems and try different creative paths and implementation paths. 2. I know the importance of intellectual property and copyright, which will play an important role in promoting my career. 3. Enhance their sense of social responsibility and value.

CHAPTER 5
CONCLUSION AND DISCUSSION

The researchers targeted "A Development of The Project-Based leaning Model for Enhancing Innovative thinking of Undergraduate Students" research leads to the following conclusions, discussions, and suggestion.

5.1 Research Objectives

5.1.1 To study the definition, and component of innovative thinking of undergraduate students.

5.1.2 To develop the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

5.1.3 To evaluate the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

5.2 Research Hypotheses

For the study, the researcher used the following two hypotheses:

1.Undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than before beginning the experiment.

2.Undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than those in the control group.

5.3 Scope of study

According to the researcher, the research scope of this study is divided into three stages, as follows:

Phase 1: Studying the definition, and component of innovative thinking of undergraduate students. Scope of the research is through literature review and interview 5 experts. The researcher synthesized to get the definition and components of undergraduate students innovative thinking. secondly, to investigate the level of

undergraduate students innovative thinking through the researcher's questionnaire on undergraduate students innovative thinking. Population: According to the <2022-2023 Yunnan Provincial Education Development Statistics Bulletin> released by the Yunnan Provincial Department of Education in April 2023, there are now 1,616,600 undergraduate students in Yunnan Province. Sample: the researcher used multi-stage random sampling method, one university in Yunnan Arts university were extracted from Kunming City, using 100 students majoring in art design to completing the questionnaire.

Phase 2: Developing a Project-Based Learning model for enhancing undergraduate students' innovative thinking. The research scope involved conducting a model design by reviewing relevant literature and interviewing 5 experts. Additionally, it considered the components of undergraduate students and their level of innovative thinking in the initial phase. Subsequently, the model was refined based on feedback from 3 evaluation experts and tested with 10 undergraduate students majoring in the same field. Ultimately, my study resulted in the final model.

Phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students. Scope of the research is Population: Yunnan Arts University undergraduate students, the students major is art design (n=100 students). Sample: This sample population was used to evaluate the use of this learning models to improve innovative thinking of undergraduate students. This sample group had 50 students, who were selected through random sampling, and who volunteered to participate in the trial. They were divided into experimental group and control group with 25 students in each group.

5.4 Research Conclusion

5.4.1 Research conclusion phase1: Studying the definition, and component of innovative thinking of undergraduate students.

The research conclusion is the describe of this study that the definition of innovative thinking. It all based on the literature reviews, and integrating the ideas of (Hart 1996)and (Morad, Ragonis et al. 2021), combined with expert interviews and

relevant literature reviews from 1912 to 2012 on the definition of innovative thinking samples, combined with the current situation of China's environment, the definition of undergraduate innovative thinking was obtained. After that, the researcher used these data content as a guide to create a Semi-Structured expert Interview. The interview questions adopted an open form to interview qualified persons of professional education students. The questions mainly involved the following three aspects: 1) the definition and components of students' innovative thinking; 2) Develop a Project-Based Learning model to enhance undergraduates' innovative thinking; 3) Methods for measuring or evaluating the innovative thinking of undergraduate students. Innovative thinking is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value.

From the expert interview, 5 Qualified experts agree, “Innovative thinking is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value. “Innovative thinking requires a certain cognitive ability to think and recognize effectively in learning activities. Being able to effectively define the problem means understanding the nature and key points of the problem, which is a very important step in the innovation process. Then, generating new ideas and putting them into practice is the core of creative thinking. The value of innovation comes from being able to effectively implement innovative ideas with meaningful results. From cognitive ability to problem definition, and finally the realization of innovative value.

At last, researchers integrated the ideas of(Hart 1996) and(Morad, Ragonis et al. 2021), combined with interviews with interviewees, and summarized the innovative thinking for undergraduate students is to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value.

One of the more significant findings to emerge from this study is that based on Ragonis, N., & Barak, M. (2021) indicate that innovative thinking 5 components as the main framework of this study, this study expanded the sample group to design disciplines for examination, Moreover, it is integrated into the design curriculum, and the expansion complements the gap of Ragonis, N., & Barak, M. (2021) that there is no design discipline group sample in the five parts of innovative thinking.

After the researcher cited past literature, there are five components of innovative thinking from (Morad, Ragonis et al. 2021) indicate that innovative thinking components, Experts agreed on the components of innovative thinking. After that, the research interview experts,5 experts in related fields put forward relevant suggestions on the components, and the current components are consistent with the research content of this paper. agreed on the components of innovative thinking.so, the researchers used the 5 components of innovative thinking as the main framework for this study.

5.4.2 Research conclusion phase 2: Developing a Project-Based Learning model for enhancing undergraduate students' innovative thinking.

The research second main outcomes is the development of a Project-Based Learning model to enhance the innovative thinking of undergraduates.

The most obvious finding to emerge from this study is that In this study, the researchers built on and integrated research on Project-Based Learning models by (Larmer and Mergendoller 2010) as a method to improve students innovative thinking. Integration this suggests using Buck Institute's Project-Based Learning general model to promote students' innovative thinking. And through interviewing experts and studying the sample definition of project-based learning in relevant literature, it is concluded that Project-Based Learning refers to: Project-Based Learning is an open-ended inquiry-based approach to teaching and learning. It enables students to have the observational skills to identify problems based on the real-world problems and tasks provided, the creativity to stimulate new ideas, the linking ability to use innovative tools for continuous inquiry, the cognitive ability to realize their self-worth and the social added value of their products through the formation of effective product development with the ability to

iterate and implement the product results into a product. And based on this definition, the researchers developed five steps of the Project-Based Learning model to enhance students' innovative thinking, which are respectively:1) Identification of need and problem. 2)Generation of new ideas. 3)Development of outcome through new Idea. 4) Implementation of new outcome. 5)Adoption of new outcome. Moreover, this model is consistent with the steps of project-based learning pointed out by (Larmer and Mergendoller 2010). Based on the research of (Barak and Yuan 2021), this Project-Based Learning model is more in line with the undergraduate learning direction under the environment of Chinese higher education and the current teaching target direction of Chinese government for higher education. And the developed model is used for experimental samples after reliability testing and inspection. This finding provides further support for the research conducted by (Chen, Lai et al. 2022), which highlighted the advantages of Project-Based Learning in enhancing innovation capabilities among Chinese students.

The researchers designed a project-based learning model consisting of 10 course learning plans with a duration of 5 weeks and a duration of 90-120 minutes each, carried out in the intangible cultural heritage creative design course. From the design of the course plan.

5.4.3 Research conclusion phase 3: Evaluating the effectiveness of the Project-Based Learning model for enhancing innovative thinking of undergraduate students.

The research third main outcomes are verified by experiments statistically significant data were obtained. The results of this research support the idea that two hypotheses.

Hypotheses 1. Undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than before beginning the experiment.

Through analysis, the process of Project-Based Learning model has a positive impact on cultivating the innovative thinking of Chinese students in terms of observation and recognition behavior. The samples were divided into experimental

group and control group by random allocation. The experimental group adopted PBL teaching method, and the control group adopted traditional teaching method. In the early stage of innovative thinking, it is found that after observation, students can have a clearer awareness of recognition and observation in the stage of concept recognition. The results of variance analysis showed that the cognitive ability of identifying needs showed 0.01 level significance (F=19.487, p=0.001). This discovery aligns with the findings of previous researchers who suggested that Chinese students can enhance their innovation capabilities through Project-Based Learning(Chen, Lai et al. 2022). The outcomes provide further support for the research hypothesis.

In terms of generate new ideas, it showed a significant level of 0.01 (F=22.318, p=0.001). The research finds that Chinese students have a high tendency in this category (Buckler and Zien 1996). Through Storytelling and SCAMPER link Idea matching, students reflect a very strong desire for learning tendency, and regard it as an important content of innovative thinking. The study found that the study recognized the importance of Storytelling, Because Storytelling offers a particularly evocative medium for articulating this vision. And consistently modify these narratives to provide novel perspectives, reveal unexplored obstacles(Buckler and Zien 1996). This finding aligns with a recent study where the implementation of the SCAMPER technique facilitated students in generating innovative solutions for addressing product-related challenges (Boonpracha 2023).

In the development of outcome through new Idea, it showed 0.01 level significance (F=19.586, p=0.001). The study found that Chinese students were not good at this stage, and students showed a very obvious subordinate position and lack of initiative. After role-playing in this stage and generating iterations through training plan projects, allow students to establish themselves as subjects and become more confident in their practical work and improve the performance of the design and problem-solving process as a whole., Role-play is being employed in various college courses to enhance students' comprehension of the subject matter, encouraging a more profound and analytical understanding. This finding is consistent with previous research

showing that shows that across the college curriculum, role-playing is employed as a means to enhance comprehension of course content by encouraging deeper analysis and critical thinking(Shapiro and Leopold 2012).

In terms of implementing results. The post-experiment significance at 0.01 level (F=33.471, p=0.001) shows that the research recognizes the importance of bridging the gap between ideas and impacts, transforming creative visions into tangible results, promoting positive changes, and creating value for individuals, organizations and society. Access is established in the form of displays and exhibitions. The study found that students had strong expectations for presentation and the transformation of practical results, and this form of strategy was also the most direct and easiest method to obtain results.

One of the significant findings from this study is the realization of the effectiveness of implementing value-added strategies. Previous research has suggested that despite the widespread practice of incorporating new educational curricula (Cardno, Tolmie et al. 2017) and utilizing innovative technologies for educational purposes (ChanLin 2017); (Nousiainen, Kangas et al. 2018), there remains a need for further exploration. In the study, the strategy that can truly Realize the adoption is to Realize added value, which not only realizes the output form of innovative thinking, but also conforms to the learning characteristics of current Chinese students. The experimental data after undergraduate participation showed 0.01 level significance (F=35.296, p=0.001). Undergraduate adoption was found to be a key determinant of the success and impact of innovative thinking, to translate creative ideas into practical benefits, and to foster sustained innovation. Then, it is a very feasible method to realize the acceptance and recognition of innovative products through whether the works apply for copyright or patent. The results also showed that through this format, undergraduates received better feedback results in terms of the added value achieved by the project.

In order to obtain more complete and credible experimental data, the experimental tracking was carried out in the fourth week after the end of the experiment. The data obtained shows that undergraduates can learn and apply, including how to analyze and evaluate the surrounding environment or the needs of others, to understand the nature of problems and influencing factors. During the creative process, I found myself able to connect the connections and associations between different fields and different concepts to generate new combinations and ideas. In the process of learning, I can consciously form and cultivate creative thinking, put forward novel and unique ideas, and transform them into feasible solutions or innovative products. It fully proves that students' innovative thinking is improved.

Hypotheses 2 Undergraduate students' innovative thinking after receiving the Project-Based Learning model and after the follow up period was significantly higher than those in the control group.

5.5 Discussion

Studying the Phase1 about Studying the definition, and component of innovative thinking of undergraduate students. Form the conclusion show that the definition, and component of innovative thinking we can gain a more suitable understanding of the innovative thinking level of undergraduate students in China.

From the Phase 2 conclusion, developing the feasibility and applicability of the Project-Based Learning model to enhance undergraduate students' innovative thinking is conducive to carrying out teaching reform. As the most important ability in the 21st century, innovative thinking is particularly urgent in China, which emphasizes innovation and development, especially in the reform of China's higher education. In this stage, through the research methods of literature analysis and expert interviews, and the analysis of IOC, a Project-Based Learning model in line with Chinese higher education is designed to improve students innovative thinking.

The results show that Phase 3 conclusion, the development of project-based learning model is very beneficial. It should be noted that Project-Based Learning has been utilized in various educational environments, spanning from early childhood

education to higher education (Kokotsaki, Menzies et al. 2016). It also confirms a 2003 study by Kanevsky and Keithley, which showed that implementing this learning model can increase students' motivation and engagement in exploring knowledge and acquiring new skills(Kanevsky and Keighley 2003).The implementation of project-based learning has been shown to significantly boost students' problem-solving skills by giving them real-world challenges to solve(Li and Jiang 2023). Project-based learning model is increasingly being embraced and gaining popularity in higher education as an effective teaching approach that promotes deep understanding and extensive learning through the integration of theory, knowledge, and students' everyday experiences (Barak and Usher 2019). In contrast to traditional teaching methods, project-based learning model stands out for its innovation and provision of multiple key strategies for success in the twenty-first century (Bell 2010). Therefore, from the perspective of college teachers, the relevant Project-Based Learning mode designed in this study is conducive to helping undergraduate teachers develop innovative thinking teaching strategies and find suitable methods to improve undergraduates' innovative thinking ability.

5.6 Suggestion

Firstly, expand sample size. The researchers intentionally employ case study methods of designated participants that are acceptable in the social sciences to gain insight into the reality of the situation. However, future studies should consider increasing the sample size to enhance the ability to generalize the findings and validate the results on a larger scale.

Secondly, the research object has certain limitations. For individual students who do not like or adapt to Project-Based Learning, do we consider other alternatives?

third: the effectiveness of the same subject across grades. Is project-based learning equally effective cross grades?

Overall, this study provides valuable ideas for cultivating innovative thinking through project learning. This method is feasible and effective in modern higher education for students with relevant academic backgrounds and future careers. Future studies can explore these aspects in order to further understand and enhance the effectiveness of educational strategies for the cultivation of college students' innovative thinking.

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APPENDIX

Appendix A:

List of Interview Experts and Experts Reviewing Research Tools

List of Interview Experts and Experts Reviewing Research Tools

"A Development of The Project-Based Learning Model For Enhancing Innovative Thinking of Undergraduate Students "study list of experts who carried out the definition of innovative thinking and the quality of its components

List of experts	Resume/position
Professor Dr. Yuan Mao Ran	Teacher Education College of Guizhou Normal University/ vice president, professor
Instructor Dr. Hua Fan	Institute of Higher Education, Yunnan University/Instructor
Professor Dr. NANTA SOORAKSA	National Institute Development of Administration / Associate Professor
Professor Dr. Yan Xiong	Yunnan Arts university / Vice President/Associate Professor
Associate Professor Dr. Li LI	The current Secretary of the Party Committee of the Education College of Yuxi Normal University. Teacher education, community education, and rural education/Associate Professor.

"A Development of The Project-Based Learning Model For Enhancing Innovative Thinking of Undergraduate Students "for evaluation in the study questionnaire on innovative thinking of undergraduate students in Yunnan Art University questionnaire was reviewed by a list of experts

List of experts	Resume/position
Professor Dr. Hong Min Zhou	Master's Supervisor at the School of Education, Jiangxi Normal University / Professor
Professor Dr. Yuan Mao Ran	Teacher Education College of Guizhou Normal University /vice president, professor
Associate Professor Dr. LI LI.	The current Secretary of the Party Committee of the Education College of Yuxi Normal University. Teacher education, community education, and rural education/Associate Professor.

List of experts responsible for reviewing the quality of Project-Based Learning models

List of experts	Resume/position
Associate Professor Dr.Yuan Zhang	Hai yuan College, Kunming Medical University/ Associate Professor
Professor Dr. Hong Min Zhou	Master's Supervisor at the School of Education, Jiangxi Normal University / Professor
Professor Yan Xiong	Yunnan Arts university / Vice President / Associate Professor

Appendix B

Semi-Structured Interview Questionnaire for Interviewing Eligible Respondents

Semi-Structured Interview Questionnaire for Interviewing Eligible Respondents

STATEMENT: This semi-structured interview questionnaire is a tool used to interview respondents for the following purposes.

Purpose of the interviews

1.To define the definition and components of innovative thinking of undergraduate students in China.

2.To gain the guidelines for developing the Project-Based Learning Model for enhancing the innovative thinking of undergraduate students in China.

3.To gain the guidelines for developing research measurement instruments to evaluate the innovative thinking of undergraduate students in China.

Part I: General Information

Name of expert.....

Educational background.....

Work Experience.....

Position.....

Organization.....

Specialized Field.....

Time and date of interview.....

Part II: Problem Orientation

Questions 1) The meaning and components of innovative thinking of undergraduate students in China.

1.1 According to you, what is the definition of the innovative thinking for undergraduate students in China?

_____

_____

1.2.1 According to the literature review, innovative thinking includes five components (Cognitive competency to identify needs. Cognitive competency to generate new ideas. Cognitive competency to change ideas to formulate outcomes. Cognitive competency to implement results. Cognitive competency to realize added value). Do you think innovative thinking with these five components is suitable for Chinese undergraduate students?

1.2.1 Cognitive competency to identify needs: refers to the ability to effectively identify or articulate a requirement or an issue.

1.2.2 Cognitive competency to generate new ideas: refers to an individual's ability to create fresh, innovative, or modified concepts and thoughts.

1.2.3 Cognitive competency to change ideas to formulate outcomes: refers to a person's ability to link newly generated or modified ideas to actual generation.

1.2.4 Cognitive competency to implement results: refers to a student's ability to successfully iterate and apply new or improved results from experiments.

1.2.5 Cognitive competency to realize added value: refers to a person's ability to accept and utilize new or improved results or solutions that provide additional benefits or advantages.

_____

_____

1.3 In addition to the five components mentioned above, do you think there are other components that reflect the innovative thinking in undergraduate students in China? What are they?

_____

1.4 In response to if there are additional components, what should the behaviors guided by those components you mentioned look like?

_____

_____

Questions 2) Guidelines to develop the Project-Based Learning Model for enhancing innovative thinking of undergraduate students in China.

2.1 In your opinion, what is the definition of the Project-Based Learning Model for undergraduate students?

_____

_____

2.2 Could you provide me with the guidelines for developing the Project-Based Learning Model to enhance the innovative thinking of undergraduate students in China?

_____

_____

2.3 What characteristics or steps provide the contents and activities of the Project-Based Learning model to enhance the innovative thinking of undergraduate students?

_____

_____

2.4 In your opinion, are there psychological techniques or other activities that can be used to enhance the innovative thinking of undergraduate students in developing the Project-Based Learning Model? If so, what kinds of techniques or activities?

_____

_____

Questions3) Guidelines for developing research measurement instruments to evaluate innovative thinking of undergraduate students in China.

1.1 It is suitable to use the innovative thinking of undergraduate students questionnaire to evaluate the innovative thinking of undergraduate students in China?

_____

1.2 In your experience, are there other measurements that can be used to evaluate the innovative thinking of undergraduate students in China? Can you give examples?

_____

_____

Appendix C: Summarizes The Main Points And Recommendations Of The Expert Interviews

Summarizes The Main Points and Recommendations Of The Expert Interviews

In the first phase of the study, the first phase of the study involved interviews with five experts with expertise in psychology, education, etc. The aim was to gather information to definition and components of innovative thinking in undergraduate students and to serve as a guide for developing models for measuring innovative thinking as well as Project-Based Learning. Key points from the interview:

The definition and components of undergraduate innovative thinking

1.1 Qualified experts agree, “Innovative thinking is the cognitive competency of undergraduate students to think and cognize in the process of carrying out learning activities, effectively defining the problem through cognition generating new or improved ideas to be applied, and effectively obtaining the results of innovative value. “Innovative thinking requires a certain cognitive ability to think and recognize effectively in learning activities. Being able to effectively define the problem means understanding the nature and key points of the problem, which is a very important step in the innovation process. Then, generating new ideas and putting them into practice is the core of creative thinking. The value of innovation comes from being able to effectively implement innovative ideas with meaningful results. From cognitive ability to problem definition, to the generation and application of new ideas, and finally the realization of innovative value.

1.2 Qualified experts agree and agree that innovative thinking should consist of five components:

1.2.1 **Cognitive competency to identify needs**. Refers to students' ability to effectively identify or articulate a requirement or an issue. Students have the observation power to identify needs, understand problems or goals in daily life situations, and thus have ability to accurately and effectively define needs and express ideas.

1.2.2**Cognitive competency to generate new ideas.** Refers to students having an individual's ability to create fresh, innovative, or modified concepts and thoughts. Ability

to think creatively, connect unrelated concepts and explore new ideas.

1.2.3 **Cognitive competency to change ideas to formulate outcomes**. Refers to a student's ability to link newly generated or modified ideas to actual generation. By linking new or revised ideas to real problems to generate effective responses and contribute to achieving results through actions, planning, and organizing resources.

1.2.4 **Cognitive competency to implement results**. Refers to a student's ability to successfully iterate and apply new or improved results from experiments. It can successfully apply new or improved experimental results in a specific group or unit, market, or organization, and have a positive impact.

1.2.5**Cognitive competency to realize added value**. Refers to a student's ability to accept and utilize new or improved results or solutions that provide additional benefits or advantages. can be able to recognize the added value of the improved results of new ideas and use their added benefits to achieve more fission capabilities. These 5 elements are in line with the concept of(Morad, Ragonis et al. 2021), which the researchers used as the main framework for this study. In addition, the qualified experts also mentioned that in order to better adapt to the Chinese cultural background, they suggested that cultural adaptability should be taken into account, and the psychological resilience of students who can solve problems collaboratively. Qualified experts also pointed out that so far, the development of China's education field in this regard is not deep and sufficient. Therefore, it is suggested that more attention should be paid to the cultivation of innovative thinking in the field of education in the future, so that students can improve the cognitive needs of innovative thinking.

2) Suggestions on the Project-Based Learning model to strengthen the innovative thinking of undergraduates

2.1) Qualified experts have the view that the Project-Based Learning model is an educational approach by engaging students in projects in their own area of interest and placing them at the center of the learning experience.

2.2) Qualified experts agree that a Project-Based Learning model should include the following steps:(1)Identification of need and problem,(2)Generation of new ideas,(3)Development of outcome through new Idea,(4)Implementation of new outcome,(5)Adoption of new outcome. These steps are in line with the theory about the Project-Based Learning model and apply these main steps when developing and designing learning activities.

2.3) Qualified experts also believe that when developing Project-Based Learning models students should learn how to ask questions, try to find several possible solutions, try new ideas to solve problems, not criticize, try to draw conclusions from their own practice, listen to different ideas of others. Create opportunities for students to work together. Skills in collaboration and effective communication are necessary.

3) To evaluate the innovative thinking measurement tools of undergraduate students

Qualified experts believe that when evaluating the innovative thinking of undergraduate students, a variety of tools (such as questionnaires, observation behaviors and interviews, etc.) can be used, and questionnaires can help understand the state of innovative thinking of students. Participatory testing can also be used.

Appendix D: Questionnaire on Innovative Thinking of College Students in Yunnan Art University

Questionnaire on Innovative Thinking of College Students in Yunnan Art University

This survey was conducted anonymously for academic research purposes, with the aim of promoting the innovative thinking ability of college students. Please fill in the questionnaire carefully and truthfully according to the prompts of the questionnaire to provide scientific basis for this study. There is no right or wrong answer to this questionnaire, good or wrong. We will keep all your information confidential. Thank you for your support!

Part 1: General information

1 College major:

2 Grade:

3 Sex:

Part 2: Measurement answer description

Please read and understand the text of each paragraph carefully and mark√. Only one answer can be selected for each question in this test. Please select the answer that best fits your situation and put a tick on the corresponding number.

1	2	3	4	5
Very inappropriate	Relatively inappropriate	Uncertain	Relatively appropriate	Highly appropriate

Innovative thinking component	Attribute level				
	1	2	3	4	5
	Very inappropriate	Relatively inappropriate	Uncertain	Relatively appropriate	Highly appropriate
I regularly observe things around me to get new ideas					
While learning, I often ask questions that challenge the status question					
I put forward my own ideas with confidence					
I regularly ask questions that challenge other learners' assumptions					
I don't think it's important to understand the main content of the problem					
I am good at identifying the needs that exist in life					
I can accurately express the real-life issues I have observed					

I look for surprising connections					
I initiate meetings with other learners to spark new ideas					
I have a network of learners whom I trust to bring new perspectives					
I create new ways of doing things					
I don't think it's important to experiment to understand how things work and create new ways of doing things					
I participate in diverse professional and/or academic forums					
I have a network with whom I interact to get new ideas					
I engage with my friends to make use of my skill					
I adopt and promote a "can do" attitude					

I see no point in focusing on what I want to achieve all the time					
I build and maintain relationships inside and outside with my friends					
I am good at identifying problems and potential solutions					
I exercise ingenuity when devising, planning and implementing solutions					
I am accountable for what i do					
I apply knowledge and skill to my daily life					
I make change visible by highlighting new products					
I identify any kind of dangers					
There is no point in avoiding any danger					
I am able to overcome					

barriers that may impede results					
I have successfully implemented my ideas					
I have the confidence to apply my skills in new and unfamiliar situations					
I can improvise					
I promote personal development in others					
Creativity and inventiveness are not necessary for me					
I possess a more attractive personal charm					
I have more competitive abilities					
I am able to apply for relevant industry patents through new ideas					

Appendix E: Results of the quality inspection of the research instrument for the Measurement of Innovative Thinking Questionnaire for Undergraduates

Results of the quality inspection of the research instrument for the Measurement of Innovative Thinking Questionnaire for Undergraduates

Consistency Index (IOC) of Innovative Thinking Assessment Tools for Undergraduates

	Expert opinion			In total	IOC	Result
	1	2	3			
1	+1	+1	+1	3	1.0	Applicable
2	0	+1	+1	2	0.67	Applicable
3	+1	+1	+1	3	1.0	Applicable
4	+1	+1	+1	3	1.0	Applicable
5	+1	+1	+1	3	1.0	Applicable
6	+1	+1	+1	3	1.0	Applicable
7	+1	0	+1	2	0.67	Applicable
8	+1	+1	+1	3	1.0	Applicable
9	+1	+1	+1	3	1.0	Applicable
10	+1	+1	0	2	0.67	Applicable
11	+1	+1	+1	3	1.0	Applicable
12	+1	+1	0	2	1.0	Applicable
13	+1	+1	+1	3	1.0	Applicable
14	+1	+1	+1	3	1.0	Applicable
15	+1	+1	+1	3	1.0	Applicable
16	+1	+1	+1	3	1.0	Applicable
17	+1	+1	+1	3	1.0	Applicable
18	+1	+1	+1	3	1.0	Applicable
19	+1	+1	+1	3	1.0	Applicable
20	+1	+1	+1	3	1.0	Applicable

21	0	+1	+1	2	0.67	Applicable
22	0	+1	+1	2	0.67	Applicable
23	+1	+1	+1	3	1.0	Applicable
24	0	+1	+1	2	0.67	Applicable
25	+1	+1	0	2	0.67	Applicable
26	+1	+1	0	2	0.67	Applicable
27	+1	+1	+1	3	1.0	Applicable
28	+1	+1	+1	3	1.0	Applicable
29	+1	+1	+1	3	1.0	Applicable
30	+1	+1	+1	3	1.0	Applicable
31	+1	+1	0	2	0.67	Applicable
32	+1	+1	+1	3	1.0	Applicable
33	+1	+1	+1	3	1.0	Applicable
34	+1	+1	+1	3	1.0	Applicable
35	+1	+1	+1	3	1.0	Applicable

Note: The consideration criteria for the consistency index from 0.50 is considered to be met and can be used.

The following table shows the discrimination of each item and the reliability of the measurement instrument.\

Authority Values and Reliability of Indicators for Measures of innovative thinking in College Students. As can be seen from the above table, the reliability coefficient value

Items	r	Appliance	Items	r	Appliance
1	0.541	Applicable	19	0.702	Applicable
2	0.679	Applicable	20	0.641	Applicable
3	0.673	Applicable	21	0.655	Applicable
4	0.637	Applicable	22	0.718	Applicable
5	0.573	Applicable	23	0.627	Applicable
6	0.687	Applicable	24	0.689	Applicable
7	0.603	Applicable	25	0.505	Applicable
8	0.674	Applicable	26	0.749	Applicable
9	0.693	Applicable	27	0.730	Applicable
10	0.701	Applicable	28	0.668	Applicable
11	0.529	Applicable	29	0.634	Applicable
12	0.670	Applicable	30	0.738	Applicable
13	0.655	Applicable	31	0.679	Applicable
14	0.656	Applicable	32	0.762	Applicable
15	0.707	Applicable	33	0.630	Applicable
16	0.702	Applicable	34	0.707	Applicable
17	0.683	Applicable	35	0.730	Applicable
18	0.750	Applicable			

is 0.872

Appendix F: Results of quality inspection of Project-Based Learning models

Results of quality inspection of Project-Based Learning models

Project-Based Learning model improves the consistency index (IOC) value of students 'innovative thinking

Learning plan	+1	+1	+1	1.00
1 The orientation of students' innovative thinking (1). Concept (2). Students (3). Objective (4). Time (5). Learning Materials (6). Step/Learning Process (7). Learning Activities Process (8). Conclusion, Evaluation	+1	+1	+1	1.00
2. Observe the batik travel products design around you 1 The orientation of students' innovative thinking (1). Concept (2). Students	+1	+1	+1	1.00

(3). Objective				
(4). Time				
(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
3. identifying batik travel products Problems				
1 The orientation of students' innovative thinking				
(1). Concept				
(2). Students				
(3). Objective	+1	+1	+1	1.00
(4).Time				
(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
4.Story generation of new ideas				
(1). Concept	+1	+1	+1	1.00
(2). Students				

(3). Objective				
(4). Time				
(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
5.SCAMPER Link Idea matching				
(1). Concept				
(2). Students				
(3). Objective				
(4). Time	+1	+1	+1	1.00
(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
6. Role-playing				
(1). Concept				
(2). Students	+1	+1	+1	1.00
(3). Objective				
(4). Time				

(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
7. Generate iterations through training plan projects				
(1). Concept				
(2). Students				
(3). Objective				
(4). Time	+1	+1	0	0.67
(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
8.Use display to test the Implementation of New Outcome				
(1). Concept				
(2). Students	+1	+1	0	1.00
(3). Objective				
(4). Time				
(5). Learning Materials				

(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
9. The acquisition of copyright or patent for the work				
(1). Concept				
(2). Students				
(3). Objective				
(4). Time	0	+1	+1	0.67
(5). Learning Materials				
(6). Step/Learning Process				
(7). Learning Activities Process				
(8). Conclusion, Evaluation				
10. Reflective learning				
(1). Concept				
(2). Students				
(3). Objective	+1	+1	+1	0.67
(4). Time				
(5). Learning Materials				
(6). Step/Learning Process				

(7). Learning Activities Process
(8). Conclusion, Evaluation

If the conformity index is judged from 0.50 or above, it is considered qualified and can be used.

Appendix G: Specific teaching activities arranged by the Project-Based Learning model to improve students' innovative thinking

Specific teaching activities arranged by the Project-Based Learning model to improve students' innovative thinking

The Project-Based Learning model plan

In developing a Project-Based Learning model to improve innovative thinking, the researchers used the textbook "Intangible Cultural Heritage Creative Design Courses" As an undergraduate course of art design in the third year of Yunnan Art University, the course lasts for 4 weeks. and will be conducted in Room 301 on the 3rd floor of the School of Design.

ime	Time of week	Learning Activity	Objective	Technique /Strategy
	Week 1	The orientation of students' innovative thinking	1. To Introduce the concept and significance of students' innovative thinking. 2. To Introduce project-based learning model and course planning.	Video resources introduce
	Week 1	Identification of need and problem ------ observe the phenomenon of batik creative design	1.To stimulate students' interest and background knowledge 2.Cultivate students' observation consciousness, and have the ability of observation and discovery through experience learning 3. Can understand and	Observe the phenomenon of batik creative design

			clearly describe the production process of batik can be implemented.	
	Week 2	Identification of need and problem------- identifying batik travel products problems	1. By effectively identifying problems that can understand and clearly describe products in specific situations, accurately sketch and analyze human product portraits and stakeholders according to project phenomena and locate demand objects. 2. To trained students recognize the observed phenomenon and bring it to the real environment and form a consciousness and cognitive sensitivity of the problem to be solved, and have the awareness of exploring multiple angles and alternative angles. 3.To develop students' practical problem-solving skills and a deep understanding of cultural products and their markets.	Identifying batik travel products Problems

	Week 2	Generate new ideas------story generation of new ideas	1. To help students carry out imaginative and innovative design creation according to the identified problems, stories are used to stimulate imagination and improve personal creative thinking ability 2. To enhance students' personal expression ability, empathy and understanding. Stories provide a platform for personal expression and self-discovery, enabling individuals to share their unique voices, experiences, and insights with others. 3. To develop a sense of community and connection. Stories have the power to build Bridges between people, create connections, and foster a sense of belonging in communities	Storytelling
	Week 3	Generate new ideas-------- SCAMPER link idea matching	1.Stimulate creative thinking and innovation by using SCAMPER to enable students to systematically link	SCAMPER Link idea matching

			insights, viewpoints, ideas, perspectives and technologies from different fields. Through the application of SCAMPER tips (replace, combine, adapt, modify, reuse, eliminate, reverse), students will develop creative problem solving, innovative thinking, and interdisciplinary collaboration.	
	Week 3	Development of outcome through new idea---- role-playing.	1.Students will demonstrate their ability in the design process of batik products, rehearse their ideas and refine the gap and contradiction between the actual results through role play. 2.To develop students' basic skills in problem solving, communication and teamwork in simulated realistic scenarios by engaging in role-playing activities. 3. Let students have a deeper and thorough understanding of the complexity of batik	Role-playing

			product design, and cultivate their innovation ability and adaptability to dynamic innovation synthesis.	
	Week 4	Development of outcome through new Idea. ---- generate iterations through training plan projects	1. To training students' ability of reflection and improvement using iterative method in the process of project development through guiding and participating in the innovation and entrepreneurship training program for college students. 2. The practical operation of students is emphasized through the activity design. Students can gain practical experience through the writing and mutual evaluation of real project books.	College students' innovation and entrepreneurship training program project book training
	Week 4	Implement results-----use display to test the implementation of new outcome	1.Students are able to develop the ability to demonstrate innovative products to the real world through collaboration with external stakeholders and develop commercial attractiveness. 2. To help students develop	Use display to test the Implementation of New Outcome

			actionable abilities to bridge ideas and influence and translate creative visions into practical outcomes. 3.To enhance their collaboration skills and understanding of the practical application of academic knowledge.	
	Week 5	Realize added value---adoption of new outcome	1.To help students build awareness within the broader context of innovative thinking and innovative ideas, practices, technologies or solutions to ensure that this novelty is widely accepted and integrated into everyday life, processes or behavior. 2. To enhance students' legal awareness to clearly establish the ownership and originality of innovation. This legal recognition helps build trust among users, stakeholders and potential investors, making it easier for them to accept innovative solutions and integrate them into	The acquisition of copyright or patent for the work

			processes or products. 3.Students possess quality and authenticity that can be used in different contexts. Copyright protection helps maintain the integrity of the work, ensuring that any adaptation or modification remains true to the original vision and purpose of the innovation.	
0	Week 5	Reviewand reflection	1. To develop self-awareness through reflective learning that encourages students to reflect on their experiences, challenges, and growth throughout the lesson plan. 2. To provide structured opportunities for students to consolidate their understanding of innovative thinking concepts and their application to real-world Settings through project-based learning models. 3. To guide students to identify and articulate the most important lessons and insights gained from the entire learning process.	Interview record

Project -Based Learning Model for Enhancing Innovative Thinking of Undergraduate students

Section 1 The orientation of students' innovative thinking

Concept

In the new era, innovative thinking is an indispensable core ability in students' study and life. Under the dual challenges of globalization and intensified international competition, we are faced with the loss of survival competitiveness, especially artificial intelligence technology continues to challenge our cognition and thinking mode, which requires us to have higher ability and quality to face complex problems and adapt to the changing social environment. Facing this challenge, in the field of education, the American Association of Colleges of Teacher Education says that higher-order cognitive abilities and skills are necessary to survive in 21st century society. Innovative thinking is considered essential for the 21st century workforce and is considered a valuable feature of human cognition.

Researchers need to understand the current situation of students' innovative thinking and adopt corresponding strategies to improve students' innovative thinking.

Students: Third year undergraduate students (Experimental group)

Objective

1. To Introduce the concept and significance of students' innovative thinking.

2. To Introduce project-based learning model and course planning.

Time: 120minutes

Teaching material: PPT, multimedia equipment

1 Step/ Learning Process:

1. Warm up

1.1 Teachers and students get to know and introduce each other.

2 Introduce

Watch the introduction of relevant clips of innovative thinking through video electronic resources.

3 Give examples

2 Learning Activities Process:

2.1 The researchers first warmly introduced and got to know the students. Then please enjoy the PPT video presentation about innovative thinking. And ask the students questions.

2.2 Free Speech. Students have 5 minutes to think "What is innovative thinking?" And communicate with your desk mate.

2.3 Teacher Examples. Explaining to students that innovative thinking involves breaking down concepts into relevant terms and providing concrete examples to illustrate how they work.

Let's consider the case of A student named A, who wants to solve the plastic waste problem in her community. A decided to use innovative thinking to come up with a more sustainable solution rather than just accepting the current recycling methods. A's innovative recycling program: A noticed that many people in her community were throwing away plastic bottles instead of recycling them, which was contributing to environmental pollution. Determined to make A difference, A embarked on a journey of innovative thinking.

Step 1 Observe and identify the problem

A Start to research plastic waste and its impact on the environment. She realized that the problem stemmed from a lack of convenient recycling options and public awareness.

Step 2: Generate ideas

A put his head together and came up with various solutions to the problem. Instead of simply suggesting more recycling bins, A thought outside the box and came up with the idea of incentivizing recycling through a reward program.

Step 3: Experimentation and prototyping

A tested her idea by creating a prototype of a reward program where people could earn points for recycling plastic bottles. She pitched her idea to local businesses and received positive feedback.

Step 4: Implement the solution

With the support of community partners, A launched her innovative recycling program. People can now send plastic bottles to designated collection points and earn points that can be redeemed for discounts at participating stores.

Step 5: Evaluate and iterate

A constantly evaluates the success of her project, gathers feedback from participants, and makes improvements based on their suggestions. Over time, the project grew in popularity and became a sustainable solution to the plastic waste problem in her community.

conclusion

Through her innovative thinking, A was able to solve a pressing environmental problem and make a positive impact in her community. Her story demonstrates the power of creative thinking, perseverance, and problem-solving skills in tackling real-world challenges. By taking A concrete example, such as A's Innovative Recycling program, students can grasp the concept of innovative thinking and understand how it can be applied to solving problems and creating positive change in the world around them.

3.1 Define innovative thinking

Through literature review, I found a lot of defining concepts about innovative thinking. In this process, the teacher listened to the students' personal views and actively communicated with them.

3.2 Group Discussion

How to improve students' innovative thinking? Invite student representatives to make presentations in class.

3.3 Project-Based Learning model

3.3.1 Definition and available value of the learning model

3.3.2 Characteristics and application steps of the model

Question:

Have you ever heard of this type of learning before? What do you think are the strengths and weaknesses of this model?

Conclusion

The positioning of students' innovative thinking is not only a necessary condition for navigating the complexities of the 21st century, but also a foundational pillar. By introducing students to the concepts and meaning of innovative thinking, combined with practical examples and project-based learning models, students are provided with the tools they need to thrive in a rapidly changing world. The ability to think creatively will not only enhance their academic and professional pursuits, but also enable them to positively contribute to society by solving complex problems and promoting sustainable solutions.

Evaluation

Teachers assess students' performance and collect their feelings, comments and suggestions. Form a student activity performance evaluation form.

Section2 Identification of need and problem ------Observe the phenomenon of batik creative design

Concept

Indeed, great innovators are great observers. (Ness, R. B. 2015). Observation is the act of intently and intentionally noticing and gathering information from the surrounding environment, experience, or existing systems. Observation skills are essential for generating new ideas, identifying problems or opportunities, and understanding user needs or market trends. Observation promotes innovative thinking in the following ways: First, attention to patterns and trends: Observation enables individuals to identify recurring patterns or emerging trends in the environment, be it consumer behavior, technological progress or social change. By keenly observing these patterns, innovators can predict future developments and identify potential areas of innovation.

Second, identify problems and opportunities. Through careful observation of how the process steps of the original batik process are completed, students can effectively identify unmet needs, inefficiencies or pain points in the existing system or process. Observation can keep us curious, open, and attentive to the world around us, constantly seeking understanding, and learning from our observations to drive meaningful innovative thinking。

Third, gain insight and inspiration. Observation enables individuals to gain insight and inspiration from a variety of sources, such as nature, art, or everyday experiences. By observing how things work in different contexts or how problems are solved, innovators can draw analogies and spark creativity, and observation plays a key role in every stage of the innovation process, from spotting opportunities and generating ideas to refining solutions and assessing their impact.

Students: Third year undergraduate students (Experimental group)

Objective

1.To stimulate students' interest and background knowledge

2.To cultivate students' observation consciousness, and have the ability of observation and discovery through experience learning

3. Can understand and clearly describe the production process of batik can be implemented

Time :120minutes

Learning Materials:

1. Textbook Creative Product Design for Non-Heritage Culture----Batik travel product design

2. Electronic video resources of excellent batik works and production processes

3. Batik products and batik material package

4. Stationery

5. Batik training room

1 Step/ Learning Process:

The researchers aroused students' interest and attention by playing the music and dress display of batik culture background. And introduce the materials and practical content needed in today's class. And start asking relevant questions to guide the students into the project topic. Then the basic knowledge of batik is explained.

The researchers will distribute relevant operational materials and experiential observation cards to enhance students' focus on the project topic and their understanding of the basic background and cultural knowledge in the early stage of the project. It can pave the way for the next class.

2 Learning Activities Process:

1 Batik products physical display and video introduction

The researcher say hello to the students, and displayed the batik national costume he was wearing. At the same time, the beautiful music was played to arouse the interest of the students and make people feel relaxed and happy. Will always carry batik products in kind, let students guess where things come from? How is it made? Then, we started to ask random questions about how much do you know about batik? Students actively participated and raised their hands to speak. At the same time, some students also showed the batik product mobile phone chain hanging on his mobile phone. Students believe that batik culture is very valuable for tourism culture and product development. Then, the researcher opened the courseware PPT to show some batik products and guided the students to carefully observe the characteristics of these product pictures. What are the phenomena? After the broadcast, the students raised their hands and said that there seemed to be some aesthetic fatigue, the product types were not rich enough, and the product design was also unattractive. It seemed that some cultural and creative products did not meet the needs of the current society. The researchers were pretty sure the students' observations were accurate. Therefore, the researchers began to introduce the project theme "How Yunnan batik cultural and creative products enhance the value of cultural tourism". The researchers explained to the students that since we want to improve the batik products, we must first learn the basic knowledge background of batik, mainly including learning from the following points: 1. Overview of batik 2. Varieties and styles of batik 3. Expansion of batik application fields 4. Development status and trend of batik industry. The researchers explained the following knowledge points in an illustrative manner.

Point 1: Overview of Batik. Definition: Batik is an ancient anti-dyeing process in which patterns are painted on cloth with wax and then dyed to create a unique artistic effect. Features: Batik has a unique ice crack effect, bright colors, rich patterns, with a strong national style and artistic charm. Origin: Batik originated in the Qin and Han

Dynasties. It is one of the ancient traditional textiles and dyeing crafts in China. Development: With the evolution of history, batik skills have been widely inherited and developed in minority areas, forming regional styles with various characteristics.

The second point: batik variety and style. Explain to the students the common patterns and colors of traditional folk batik, such as flowers, birds, fish and insects, landscapes and so on, as well as their meanings and symbolic meanings.

The third point is the expansion of batik application fields. This paper analyzes the development trend of modern creative batik in pattern design, color application and technology. Explain the artistic characteristics of modern creative batik, and show the application works of modern creative batik in clothing, home furnishing, art and other fields.

Point 4: Development status and trend of batik industry. The current situation mainly focuses on the living room decoration, bedroom decoration, clothing, and cultural creation. The future development mainly focuses on painting creation, the application of batik patterns to ceramic, glass, metal and other materials on the combination of handicraft design, as well as mural creation, digital batik, cultural and creative design and other research fields.

2 Seeing is believing

The researchers started with a concrete demonstration of the batik experience. Then, the batik material kit was distributed to the students. After the students put the batik tools in place, the students were instructed to carry out the process of batik practice operation, and the batik experience observation study sheet was issued.

Step 1: Ask students to prepare tools. Take out the wax knife and cloth, place the wax melting machine next to the table, and wait for all the wax to dissolve.

Step 2: Paint (paint wax). Use a wax knife to start painting wax on the cloth,

design butterflies, fish shapes, and other patterns. At the same time remind students waxing skills, wax material should be distributed on the cloth, avoid repeated application of wax in the same area, so as not to lead to too thick wax layer affect the dyeing effect; Pay attention to wax temperature control to avoid burns.

Step 3: Soak in cool water. After drawing the pattern, put the cloth in the cold water and soak it. At the same time, the teacher prepares the clip.

Step 4: Dip. Soak every 15 minutes and let dry for 20 minutes. Repeat 3-5 times.

Step 5: Flush wax. Rinse with high temperature and high-pressure water. Note that you can use smooth stones to press down on the dyed cloth to prevent it from being washed away. Or you can use another method, boil the cloth with boiling water, swing the cloth like rinse the hot pot, and then take out the floating wax. It is usually 5 minutes long.

Step 6: Let dry (let dry without wringing).

After completing the above steps, students will complete the batik experience observation study sheet at the same time.

3 Observe sharing and exchange presentations

After the students completed the exercises by themselves, they observed the study sheet according to the batik experience and showed their batik works to the teacher and classmates. The following questions need to be addressed:

1: What problems will be encountered in the operation process?

2. Do you find this activity appealing to you?

3. What were the main problems you encountered during the experience?

4. What kind of batik culture creations do you think can be more attractive?

5: How do you think batik cultural and creative products should be improved?

Conclusion

Students have a basic understanding of the batik culture and operation process, and carefully observe the batik operation process video and production experience, from which Master and understand the basic knowledge of cultural background and improve the degree of attention and interest. And through specific practical operation, to develop the ability of observation and hands-on operation.

Evaluation

1. Observe the degree to which students participate in learning activities, including discussion and sharing sessions, and the frequency of interaction between students and teachers.

2. The students' practical assignments and experience observation study sheets were collected to evaluate the students' observation ability and operation ability.

Batik experience observation study sheet

tudy patterns in class	composition	Meaning	Type of product commonly used	Technique of expression
Butterfly pattern				
Fish pattern				
Other patterns				
Summary of batik production process and work creation steps:				
1. 2 3.				
The observations are shown:				
Pattern				
graph				

composition	
Product types that can be extended	
Reflection on observational learning	
1. What problems will be encountered in the operation process? 2. Do you find this activity appealing to you? 3. What were the main problems you encountered during the experience? 4. What kind of batik culture creations do you think can be more attractive? 5: How do you think batik cultural and creative products should be improved?	

Section3 Identification of need and problem------- identifying batik travel products problems

Concept

Identification refers to recognition and discrimination. The ability to act as a catalyst for innovation is a problem, need, opportunity, or challenge. Identification is the first step in the innovation process, where individuals or teams actively seek to understand and clarify the context in which innovation is needed. Recognition of a problem or need: Innovative thinking involves keenly observing the world and identifying areas where there are unmet needs, inefficiencies, or challenges. This awareness often stems from observing the gap between existing solutions and expected results or experience. 2. Define scope: Identification involves defining scope and boundaries of a problem or opportunity. Identification also requires understanding the perspectives, motivations, and needs of stakeholders affected by or involved in a problem or opportunity. 3. Analyze root causes: Innovative thinking involves looking beyond the surface symptoms to find the root cause of a problem or opportunity. This method of analysis helps to reveal the factors causing the problem and inform the development of

more effective solutions. 4. Explore alternative perspectives: Identification requires being open to different perspectives and alternative perspectives. Innovative thinkers actively seek input from diverse sources, such as interdisciplinary experts, users with diverse demographics, or individuals with non-traditional backgrounds, to gain a comprehensive understanding of a problem or opportunity. 5. Define problems creatively: Identification involves defining problems or opportunities in a way that stimulates creative thinking and ideation. The ability to identify effectively is the foundation of innovative thinking, as it lays the foundation for generating creative solutions and driving meaningful change. Gain effective recognition by experiencing strategies in real life scenarios.

Students: Third year undergraduate students (Experimental group)

Objective

By effectively identifying problems that can understand and clearly describe products in specific situations, accurately sketch and analyze human product portraits and stakeholders according to project phenomena and locate demand objects.

2. To trained students recognize the observed phenomenon and bring it to the real environment and form a consciousness and cognitive sensitivity of the problem to be solved and have the awareness of exploring multiple angles and alternative angles.

3.To develop students' practical problem-solving skills and a deep understanding of cultural products and their markets.

Time :120minutes

Learning Materials:

1. Drawing board
2. Stationery supplies
3. Wax dyeing product trading market

4. School buses and other means of transportation

5. Research notebook

1 Step/Learning Process

Implement real-world experience strategies to identify current issues in batik tourism products, including immersive, hands-on experiences that allow participants to interact directly with products, environments and users. This approach can reveal insights into user needs, product flaws, and opportunities for innovation. Here are the steps:

1 Goal setting

Define the goals of the experience, identify user needs, identify product pain points and explore new market opportunities.

Background knowledge

Review the background information of batik cultural and creative products, including its history, cultural significance and current market trends.

Expectation setting

What students should focus on during the experience, such as observing user behavior, usability of the product, or specific challenges faced by the user.

2 An immersive experience

Field trips

Organize a visit to the location where batik tourism products are sold or used, and this selected batik product sales market.

Direct interaction

Students are encouraged to use batik travel products themselves, interact with

owners and sellers, and talk to customers to gain first-hand insights.

Identification task

Students are assigned specific identification tasks, such as noting how easy it is for visitors to find and choose batik products, what problems they have, or what difficulties they encounter.

3. Reflect and report

Panel Discussion

After the immersive experience, students are divided into groups of 4, for a total of 20 students, grouped together into 5 groups. Facilitate group discussions where participants share their observations, insights and surprises.

Determine the topic

Work together to identify common themes, recurring problems, and unique insights that emerge from the experience.

Personal reflection

Participants were asked to reflect on their experience individually, focusing on how it changed their understanding of Batik cultural and creative products and their users.

Problem identification

Incorporate findings to gather and organize insights from discussions and reflections to identify key issues and challenges facing batik tourism products.

Priorities

Prioritize problems based on factors such as frequency of occurrence, impact on the user experience, or feasibility of solving the problem.

2 Learning Activities Process:

Real life scene experience strategy

The researcher said hello to the students, explained the process and requirements of today's specific real life scene experience, and returned to the reality with the problems observed in the last class to truly implement the experience and feelings. At the same time, the students were informed that the place they were going to today was the Batik product market, and the students were guided to take the school bus to experience the real-life scene in an orderly way according to the requirements. At the same time, the relevant learning forms were distributed to the students in the form of paper, including (Batik cultural products survey list and Problem identification record sheet). According to the College regulations, each student is required to complete the safety Agreement (Safety Agreement form attached). The whole process of the activity was mainly carried out according to the following procedures, and the researchers led the team to explain the whole process.

1 Set goals

Clear objectives: First, the researcher clearly explains the objectives of the project to the students, ensuring that they understand that the focus is on identifying user needs, identifying product pain points, and identifying new market opportunities related to batik tourism products.

Background knowledge

In the last lesson, we have a general understanding and understanding of the basic cultural background knowledge of batik through video process and practical operation.

Expectation setting

Guided focus areas: Students are provided with checklists to guide them in identifying types during field trips. The list should include specific aspects such as the user's interaction with the product, the accessibility and visibility of the batik product in the market, and any observed challenges or obstacles faced by the user or seller. Students first need to complete Batik cultural products survey list. A sample list is as follows:

Batik cultural products survey list		
Product Type:		Identification result
User interaction with the product	Level of engagement: Observe how customers interact with batik products. Whether they are attracted to certain patterns or colors	
	Usage understanding: If the customer seems to understand the various uses of batik products (e.g., clothing, accessories, home decor)	
	Emotional reactions: Pay attention to emotional reactions to batik products. Do certain designs evoke joy, curiosity, or indifference?	
Accessibility of batik products	Product placement: Evaluate how batik products are presented in the market. Are they prominent or hard to find?	
	Availability of information: Observe whether information about batik products is readily available (e.g., origin, process, care instructions)	
	Physical accessibility: Consider the physical accessibility of batik product display. Can all customers easily access and inspect the product?	

The popularity of batik products in the market	Logo and promotion: Note the presence of logo or promotional materials to highlight batik products. Is marketing effective in attracting attention?	
	Online awareness: If applicable, evaluate the online presence of batik sellers or marketplaces. How do batik products perform on websites or social media?	
	Cultural expression: Assessing how batik products are positioned as part of cultural heritage. Is this aspect being exploited in their presentation and marketing?	
Challenges or obstacles faced by the user	Price perception: Measures customer response to price. Does price seem to be a barrier to purchase?	
	Knowledge Gaps: Identify any noticeable gaps in customers' knowledge that would prevent them from appreciating or purchasing batik products.	
	Strategic Support: Observe whether and how the seller helps customers make informed decisions about buying batik products	
Challenges and obstacles for sellers	Inventory management: Be aware of any problems the seller has in managing the inventory of batik products, such as having too much stock or not enough stock for certain items	
	Customer engagement: Assess the challenges sellers face in attracting customers, including language barriers, explaining the value of	

	batik, and handling negotiations	
	Market competition: Observe how sellers differentiate their batik products from their competitors. Are there obvious difficulties in standing out in the market?	

The researchers describe the use of the identification checklist and encourage students to use the checklist as a guide for detailed recording and observation. This is good for them:

Capture specific examples and anecdotes that illustrate each focus area.

- Take photos (where permitted) to support their identification.

- Consider not only the existence of these factors, but also their quality and effectiveness.

After a field trip, students can use the insights gleaned from this checklist to engage in in-depth discussions, identify patterns and anomalies, and come up with informed solutions to identified challenges. This structured approach not only enhances their learning experience, but also fosters analytical and problem-solving skills.

2 The immersive experience begins

Organized visits: Organized visits to markets known for selling batik tourism products ensure that students have opportunity to identify, interact and engage with the environment in a meaningful way. Arrange guided Tours with market officials or sellers who can gain insight into the workings of the market and the batik products available.

Direct interaction

Students consult merchants as consumers and communicate and interact with them. This exercise is designed to develop empathy and deepen understanding of the

interactions and transactions involved.

Recognition task

Specific identification tasks: Complete the batik tourism product identification list form according to the goals set at the beginning of the project.

Reflect and report

3 Group discussion

Organized group discussions: After the site visit, organized group discussions were organized within the five groups. Provide a set of guiding questions to help steer the conversation toward meaningful insights and observations related to the project's goals.

4.Problem identification

Problem level identification cards were issued to students to help students establish a cognitive ladder for identifying problems. Then the discussion began, and each group presented the recognition results for different problems according to the problem hierarchy identification cards.

Problem hierarchy	Examples	Problem identification record
Problem of memorization	When and where did batik originate?	
Understand the problem	What are the main thoughts and emotions expressed in the Great Kowloon by Ma Zheng Rong, a famous batik artist?	
Application Issues	Are traditional batik works still applicable in modern society?	

Inference problem	Is traditional batik only used as decoration?	
Analyze the problem	Is the simulation of batik effect by computer software or the application of batik patterns to digital products the integration or destruction of traditional crafts and modern science and technology?	
Problem of synthesis	Is there a connection between batik and theater culture?	
Evaluation problem	What kind of batik products are more popular?	

Problem identification record sheet

Conclusion

3.1 Students can identify the diversity of direct and indirect senses by fully mobilizing them, thus helping to better locate project problems.

3.2 Students can identify and clearly express the results after identification and make a list of data collection with realistic problems.

Evaluation

1. Students should have a complete and clear identification list of batik tourism products, which is referable and practical.

2. Be able to fully express their own opinions and identify key issues and challenges faced by batik tourism products.

Security protocol for Yunnan Arts university

云南艺术学院高等职业教育学院学生外出采风考察安全协议书

甲方：云南艺术学院高等职业教育学院　　（以下简称甲方）

乙方：　　电话：　　（以下简称乙方）

为了确保艺术采风的顺利进行，增强学生的安全意识，圆满完成采风考察课程，经双方协议如下：

一、甲方责任

1、甲方在艺术考察前，对乙方进行安全教育。

2、甲方在艺术考察期间派出指导老师对乙方进行指导，对考察地点的各项事宜进行协调沟通，进一步对学生进行安全教育。

二、乙方责任

1、必须遵守国家法律、院纪院规、交通规则、学生守则，尊重民族地区的风俗习惯。

2、乙方应认真履行采风考察期间的各项安全要求，严格遵守带队老师的各项安排，一切在带队老师指导之下活动，严禁独自行动，确保安全。

3、乙方在采风期间，要严格遵守纪律，确保自身安全，以防意外事故发生；严禁一切危险、违法活动；严禁进网吧、歌厅等场所、严禁酗酒、严禁夜不归宿、严禁聚集赌博、谨慎交友、注意自身防范。违法相关规定者，产生的一切后果自己负责。

4、乙方在采风期间，不得擅自离开团队独自行动，一切安排听从团体安排，服从团体。

5、乙方在采风期间，不得与人发生口角，注重礼貌待人，体现我院学子良好的精神风貌。

6、在外采风期间，各班严格执行考勤，必须在规定时间，规定集合地点准时准点准确的集合，各班班长每天负责清点各班人数，并每天准时上报。如人数有缺，应及时上报指导老师，并落实不在人员去向及情况，并联系到本人。

三、违约责任

1、乙方（学生）在考察期内，不遵守带队老师的指导和要求者，擅自离开者、不在规定时间，规定地点集合者、不配合团队活动及团队利益者、如出现意外安全事故的由乙方自己负责处理。

2、如果乙方（学生）采风期间因违反本协议，由自身原因而引起的人身伤亡事故，由乙方自己承担全部责任。

3、乙方（学生）考察期间，确需暂时外出或其他特殊情况，必须提出书面申请，征得带队老师的同意批准，并跟学校取得联系后方可离开。否则，由此引发的一切安全责任，由乙方承担。

四、其它约定

本协议一式两份，学校和学生各留一份，双方签字后生效。

甲方：云南艺术学院高等职业教育学院　　乙方：（学生签字）

年　月

Section 4 Generate new ideas------Story generation of new ideas

Concept

We found that stories communicate vivid im- ages of most important beliefs. Storytelling offers a particularly evocative medium for articulating this vision. And continually reshape these stories to offer fresh insights, uncover new challenges(Buckler and Zien 1996). Stories have an extraordinary capacity to stimulate creativity, to stimulate our imagination, emotions, and intelligence in ways that transcend facts or information. Here's how stories inspire creativity and foster innovative thinking: First emotional engagement, stories evoke emotions and create a powerful connection between the audience and the narrative. Emotional resonance can inspire empathy, curiosity, and passion, spark creative imagination, and inspire individuals to explore new ideas or perspectives. Second to identification and empathy, well-crafted stories often feature related characters facing challenges or dilemmas. By identifying with these

characters and their struggles, individuals can gain insight into their own experiences, beliefs, and aspirations, leading to a deeper understanding of themselves and others. This empathic connection can inspire creative solutions to personal or social problems. The third is imagination and visualization, where stories take us to different worlds, times and realities, stimulate our imagination and expand our cognitive horizons. Through vivid descriptions, rich images, and sensory details, stories paint a vivid picture in our minds, enabling us to imagine possibilities, explore different perspectives, and envision innovative solutions to complex problems. Fourth, exploration of themes and concepts: Stories often explore universal themes such as love, loss, friendship, and courage through metaphor, symbolism, and allegory. By working to address these topics, individuals can gain a deeper understanding of the human condition, social issues, and issues of survival, triggering creative reflection and inquiry. Stories inspire creativity by engaging our emotions, stimulating our imagination, challenging our assumptions, and fostering empathy and understanding. By immersing ourselves in rich narratives, we can unlock new perspectives, envision innovative solutions, and harness the power of storytelling to drive positive change and transformation.

Students: Third year undergraduate students (Experimental group)

Objective

1.To help students carry out imaginative and innovative design creation according to the identified problems, stories are used to stimulate imagination and improve personal creative thinking ability

2. To enhance students' personal expression ability, empathy and understanding. Stories provide a platform for personal expression and self-discovery, enabling individuals to share their unique voices, experiences, and insights with others.

3. To develop a sense of community and connection. Stories have the power to build Bridges between people, create connections, and foster a sense of belonging in

communities.

Time :120minutes

Learning Materials:

Writing materials for storytelling (pen, paper)

Presentation materials (slides, visual effects)

1Step/Learning Process:

Storytelling Workshop:

The researchers announced today's theme: A day of storytelling. Based on the problems of batik cultural and creative products identified in the last class, the strategies of narration and Jeanie story ideas are used to stimulate everyone's creativity. Students were given 20 minutes to prepare for a sample story and then presented on stage in groups.

1.1 Introduction to Storytelling: The researcher introduces the concept of storytelling and its importance in effectively communicating ideas. Examples of effective storytelling are shared.

1.2 Students share and tell stories.

2 Learning Activities Process:

The researcher first greeted the students and announced that the topic of the day was storytelling. And start telling a sample story:

Once upon a time, in a small village nestled among lush green forests and winding rivers, there lived a young craftsman named Xiao Ya. Xiao Ya is passionate about preserving her cultural heritage through her craft of batik.

As Xiao Ya strolls through the village, she marvels at the bright colors and intricate patterns of batik textiles adorning the market stalls. She feels a deep

connection to the stories and traditions woven into every fabric, but she is also eager to incorporate modern elements into her designs to appeal to a wider audience.

One day, as Xiao Ya sat in the shade of a towering banyan tree, inspiration struck like lightning. She envisioned a line of batik products that would not only celebrate the rich heritage of her ancestors, but also embody the spirit of innovation and creativity.

With a newfound determination, Xiao Ya embarked on her creative journey, sketching designs that seamlessly blend traditional themes with modern elements. She uses the natural beauty around her - the delicate petals of tropical flowers, the graceful dance of palm leaves in the breeze - to create patterns of harmony and balance.

As Xiao Ya experimented with different color combinations and techniques, she discovered new ways to breathe life into her designs. She experimented with eco-friendly dyes made from local plants and herbs, infusing her creations with sustainability and respect for the environment.

With each tap of the brush and the soaking of the fabric in the dye bath, the elegant vision begins to take shape. She envisions her batik products adorning people's homes around the world, spreading joy and inspiration wherever they go.

Finally, after weeks of unremitting effort and unwavering dedication, Xiao Ya revealed her collection to the world. From vibrant scarves and tapestries to elegant home decor and accessories, each piece tells a story of tradition, innovation and the timeless beauty of batik.

As news of Xiao Ya's extraordinary creation spread, people from far and wide flocked to her village to marvel at her work. They were attracted by the intricate designs and bright colors, but more importantly, they were moved by the passion and love that Xiao Ya poured into each piece.

And so Xiao Ya's journey came full circle, from the quiet streets of her village to

the bustling markets of the world. Through her art and imagination, she has not only preserved the legacy of batik, but also blazed a new path for future generations.

After the story, the researchers asked the students to answer the following questions.

The researchers asked: What is the story about?

Student A replied: "This story is about the journey of a young craftsman Xiaoya, who is committed to protecting and inherits the cultural heritage of batik art, while incorporating modern elements to innovate."

What do we learn from this story?

Student B replied: "Through this story, we learn about creativity, dedication and the importance of cultural heritage. Through unremitted efforts and innovation, Xiao Ya has successfully combined traditional batik techniques with modern elements to create unique and attractive products that demonstrate respect for tradition and exploration of the future."

"Who do you think would like to hear this story?" the researcher asked.

C replied, "I think people who like to hear this story include people who are interested in art, culture and innovation, and those who like to see a person achieve their dreams through hard work and dedication."

The researchers asked, "How do you feel about the storyline, the design, the conflict points, the twists and endings?"

D replied: "The plot is set in a small village between a lush forest and a winding river. It mainly focuses on how Xiao Ya combines traditional batik technology with modern elements. The conflict point is the conflict between tradition and modernity, and how to protect the cultural heritage. The turning point was when she had an Epiphany

under the Banyan tree and began to conceive innovative batik products. The end result is that Xiao Ya, through creativity and dedication, has successfully presented her creation collection, which has been appreciated and recognized by people."

"From this story, how do you think the protagonist gained access to batik product innovation?" the researcher asked.

"From this story, it can be seen that the main protagonist Xiao Ya obtained the innovation of batik products mainly by conceiting the idea of blending traditional and modern elements, and then putting it into practice, constantly trying and exploring new color combinations and techniques, and finally creating unique and attractive works. She also pays attention to environmental protection and sustainability, using local plants and herbs to make eco-friendly dyes, which shows respect and care for the environment."

2.2 Storytelling exercise: Prepare to start the storytelling exercise, give everyone 20 minutes to prepare, organize 5 groups of students to tell the story, and give students the identification problem and the story generation bridge card to fill in. After filling out the card, the students will fill out the product story generation exercise card, and the students will carry out the story idea and setting according to the card prompts. After getting the card, students designed the story of batik cultural and creative products according to the problem level determined by themselves.

1: Product story generation exercise cards		
Topic	Objective	Listeners
What is the product story about?	What can you accomplish with this product story?	Who is listening to the product story, and what are their needs?
Beforethe	What is the audience thinking, feeling, and understanding before	

product story	they hear your product story?
Settings	Set the time, place, and context of the product story
Conception	Product story development clues, plot, action, conflict
conflict	The forces of opposition
Turning point	Ups and downs, changes, plot developments
The End	Analysis and resolution of things
After telling the story	After the product story

2: Identify the problem and the story to generate a connection bridge card				
The issues around which the story revolves	The story line forms the key words	opic	Basic action	New ideas
Problem of memorization	Time and time travel			An illustrative story
Understandthe problem	Look for story lines that are closely related to current events			Interactive stories
Application Issues	Experience and practice, "if story"			Experience stories
Inference problem	Backward thinking			Scalability Story
Analyze the problem	Change the visual shape			Expressive story
Problem of synthesis	The plot twists and turns to "trick" the audience, comedy and humor			Derivative stories

2.3 Peer feedback and reflection: Students share their stories with peers and provide feedback to each other. They reflect on their storytelling skills and identify areas for improvement.

Conclusion

3.1 Through storytelling workshops, students can explore new perspectives, challenge assumptions, imagine alternative futures and unleash their creativity.

3.2 By practicing storytelling skills and getting feedback from peers, students develop valuable storytelling skills that will improve their ability to link and communicate ideas effectively in a variety of contexts. Empowering individuals to put themselves in others' shoes, experience different perspectives, and connect with shared human experiences fosters empathy and understanding. By fostering empathy, storytelling can promote compassion, tolerance, and mutual respect.

3.3 Storytelling enables students to share their voice, express their truth, pursue their dreams, and develop confidence, resilience, and agency. You can explore your own identity, face challenges, and discover your strengths in order to achieve personal growth and achievement.

Evaluation

1. Students' storytelling performance will be evaluated for their ability to capture batik creative ideas, artistic expression and generate new ideas. Evaluate the originality and relevance of the story to determine its effectiveness in inspiring creativity and driving positive change.

2. Peer feedback and product story generate feedback from exercise cards to obtain whether the creative points inspired by the story meet the needs of the audience.

Section 5 Generate new ideas-------- SCAMPER link idea matching

Concept

The concept of linking plays a vital role in connecting the different elements of the innovation process. The ability to make connections, relationships, or associations between different ideas, concepts, or information. Here's how the linking promotes innovative thinking: 1. The integration of ideas: linking involves integrating different ideas, perspectives, or areas of knowledge to create innovative solutions. It requires synthesizing information from multiple sources and combining seemingly unrelated concepts to generate new insights or approaches. 2. Connecting insights: innovative thinking involves identifying patterns, trends, or insights and connecting them to relevant contexts or challenges. This process of connecting insights helps innovators recognize opportunities to apply existing knowledge or experience to solve new problems or address new needs. 3. Bridging gaps: Connecting also involves bridging the gap between existing solutions and expected results. Innovators identify the differences between the current state and the ideal state, and then explore ways to link available resources, technologies, or strategies to effectively close those gaps. 4. Cross-pollination of ideas: Innovative thinking thrives in cross-pollination, where ideas in one field connect with ideas in another, enriching ideas in another. This process often leads to breakthrough innovation by transferring successful strategies, methods, or principles from one environment to another. Innovative thinking training tools are resources, methods, or technologies designed to cultivate and enhance an individual's ability to think creatively, generate novel ideas, and respond to challenges innovatively. These tools are designed to foster a mindset conducive to innovation and provide a practical framework for developing innovative thinking skills. SCAMPER, an innovative thinking training tool, facilitates the process of ideation and elaboration. When students generate

ideas using SCAMPER prompts, they have opportunity to test, iterate, and refine their concepts based on feedback and insights gained along the way. This linking approach enables students to continually improve their ideas and develop more innovative solutions over time.

Students: Third year undergraduate students (Experimental group)

Objective

Stimulate creative thinking and innovation by using SCAMPER to enable students to systematically link insights, viewpoints, ideas, perspectives and technologies from different fields. Through the application of SCAMPER tips (replace, combine, adapt, modify, reuse, eliminate, reverse), students will develop creative problem solving, innovative thinking, and interdisciplinary collaboration.

Time :120minutes

Learning Materials:

1.SCAMPER Framework guide or handout explaining each of the seven tips and their application.

2. Examples or case studies that show how SCAMPER can be used to inspire innovation and improvement in different industries or environments.

3. Write materials for notes, idea generation, and insight and solution documentation.

4. Access to technical tools and software for digital collaboration, prototyping, and visualization (e.g., collaboration platforms, graphic design software, prototyping tools)

1Step/ Learning Process :

First introduce SCAMPER to students. They are then given specific tasks, using

SCAMPER prompts to stimulate creativity and outline their ideas, and discuss the potential benefits and challenges of each concept. This is followed by prototype testing and finally presentation and reflection.

2 Learning Activities Process:

SCAMPER：

2.1 The researcher first introduced the SCAMPER technology to the students and its purpose of fostering innovative and creative thinking. Its basic steps include substitution, combination, adaptation, modification, transformation, elimination, inversion. SCAMPER is a creative thinking technique that can be applied to various industries to inspire new product concepts and improvements.

SCAMPER, created by American psychologist Robert Abel, is a series of specific methods for stimulating creativity, adapting and modifying and making new products.

1: Substitute (What can be substituted?) What can be replaced? What characters can be replaced? Can I change the composition or material? Can I use another method?

2: Combine (Can be combined with what to become one?) What ideas do you have for merging? For what purpose can it be merged? What materials, what functions, what content can be incorporated? What are the processes, steps that can be combined? Can you offer a range of products or packages?

3: Adapt (Is there any place for the original to adapt?) Is there anything else similar to your product? Where can you take from and imitate and adapt, adjust? What other ideas can you introduce? Do you have any other techniques you can use here? Do you have ideas in other areas that you could use?

4: Modify (Can change some characteristics of the original object, such as size, color, shape, sound, taste, packaging, name, etc.) Could you change the order? What can I zoom in on? What is there to exaggerate? What could be higher, longer, stronger, more frequent? What can you push to the extreme, increase to the maximum or minimum?

5: Put to another use? (Are there new ways to use it?) Are there any other uses for this extension? What other uses do you have for your product? Is there any other use after improvement? Are there other markets?

6: Eliminate (Can you make the original smaller?) Concentrate? Or omit certain parts? Make it more complete, more polished) What happens if I delete a certain part? What is necessary or unnecessary? Can I cancel these rules?

7: Reverse (Is it possible to reorganize or rearrange the original order? Or switch the positions?) What happens in reverse? Up and down, left and right, front and back? Can time be reversed? Can the order be reversed? Are the components of the product interchangeable? Can there be other constructions?

2.2 For example, the innovative dismantling case of a pencil.

Abbreviations	Notes	Point of entry	Thinking	The solution	Presentation
S	substitute	What can be substituted?	What if the orange of the pencil was replaced with the texture of the bark made of ceramic?	This might make the pencil more durable and interesting	
C	combine	With what can be merged into one?	Combine a pencil with an animal	Interesting and visually good	
A	adapt	Is there any adaptation of the original?	Make the pencil bend	Solved the pen has been staying in the pen holder situation, the original pen can also hang.	
M	modify	Can you change certain characteristics of the original, such as size, color, shape,	What if you made a pencil with a pattern so that every time you sharpened the pencil, the exposed part of	Publicity, environmental protection That's not cool, art	

		sound, taste, packaging, name, etc.	the lead was shaped like a star or a heart?		
P	Put to another use	Are there other non-traditional uses?	Add LED lights to the pencil	Atnight, homework or painting is not afraid of light	
E	eliminate	Is it possible to make the original smaller? Concentrate? Or omit certain parts? Make it more complete and more sophisticated	It is possible to design a pencil without a wood shell	Just use a special wrapping material so you don't have to sharpen your pencil. It will feel new	
R	reverse	Can you reorganize or rearrange the original order? Or switch the positions?	We put the tip of the pencil to the other end, a thick tip at one end and a thin tip at the other, so that only one pencil is needed for coloring and writing	Powerful	

2.3 SCAMPER Workshop:

Five groups were assigned the task of designing batik products using the SCAMPER framework. SCAMPER check sheets were handed out to students to guide them through each step of the SCAMPER process, encouraging them to brainpower and think critically about how to innovate in the assigned area. Use the SCAMPER technique to stimulate creativity. Students are encouraged to outline their ideas and discuss the potential benefits of each concept. This process needs to continue for a period in the class and finally present their final batik cultural creative product design ideas, explaining the creative process they followed and the innovative characteristics of the design.

Through this structured learning process and the application of SCAMPER technology, students acquire innovative approaches and strategies for batik cultural and creative products, while enhancing their creativity.

Conclusion

By systematically applying SCAMPER tips (replace, combine, adjust, modify, reuse, eliminate, reverse), individuals and teams can challenge conventional thinking, break through psychological barriers, and discover creative solutions to problems or opportunities. SCAMPER encourages divergent thinking and exploration that links multiple perspectives, fostering a culture of creativity and innovation within an organization. It enables individuals to redefine problems, question assumptions, and generate new concepts that may not have been considered.

Evaluation

Feedback and verification: Participants' SCAMPER checklist was collected to assess the originality, feasibility and potential impact of the ideas proposed by the students.

SCAMPER checklist

ypes	Notes	Point of entry	Think (how to do it)	Answer (Purpose)
S	substitute	What can be replaced?		
C	combine	what can be merged into one?		
A	adapt	Is there any adaptation of the original?		
M	modify	Can you change certain characteristics of the original, such as size, color, shape, sound, taste, packaging, name, etc.		
P	Put to another use	Are there other non-traditional uses?		
E	eliminate	Is it possible to make the original smaller? Concentrate? Or omit certain parts? To make it more complete and more sophisticated?		
R	reverse	Can you reorganize or rearrange the original order? Or switch the positions?		

Section 6 Development of outcome through new Idea.---- Role-playing

Concept

Innovative thinking is seen as an ongoing process rather than a one-off event. That is, the innovator must go through the process of critical thinking to produce iterative effects that promote the generation of results. Students are asked to think creatively and critically. They must analyze and synthesize content innovatively. Completing these tasks also requires a thorough understanding of the challenging course material and mastery of linguistic and cognitive skills.

Across the college curriculum, role-play is being used to facilitate a deeper and more critical understanding of course material(Shapiro and Leopold 2012). By the mid-1980s, role-playing pedagogy had come to include everything from quick warm-up games to more extensive projects requiring weeks of preparation (Ladousse 1987).Like any pedagogy, role-play can indeed be used uncritically, and the focus can shift easily from learning to entertainment(Shapiro and Leopold 2012).

At the same time, in this process, it can also promote students to accept subject skills and improve students 'professional ability. The role play method fully establishes the subject status of students and can also make students more confident in the actual work in the future.

Students: Third year undergraduate students (Experimental group)

Objective

1.Students will demonstrate their ability in the design process of batik products, rehearse their ideas and refine the gap and contradiction between the actual results through role play.

2.To develop students' basic skills in problem solving, communication and teamwork in simulated realistic scenarios by engaging in role-playing activities.

3. Let students have a deeper and thorough understanding of the complexity of batik product design and cultivate their innovation ability and adaptability to dynamic innovation synthesis.

Time :120minutes

Learning Materials:

1 Batik equipment and materials

2 Digital design software (such as CAD)

3 Prototyping tools (such as 3D printers)

4 School intelligent classroom

1Step/Learning Process

Role play: The researchers will first explain the basic requirements for conducting simulation exercises and role-playing arrangements. The researchers announced the creation of a real scenario case: the college students' Innovation and Entrepreneurship project is currently carrying out the design of batik culture and innovation project in Malipo County, WenShan Zhuang and Miao Autonomous Prefecture, Yunnan Province. Malipo County hopes to develop the tourism economy of Malipo County by designing a batch of culture and innovation products as a diversion point for Internet red. According to this scenario, the researcher introduces the roles to the students. The researchers designed four personas -2 Malipo local village representatives, 1 designer, l village director, and 1 tourist. And based on the real scene of Malipo County villagers, village director role, the role of tourists to understand and guide the interpretation. Guide students to experience the role. Then, the role play evaluation is explained and explained.

2 Learning Activities Process

The researchers carried out the specific implementation process of the role play method and explained to the students the following steps in the implementation process: preparation stage, guidance stage, play stage, evaluation stage, and comprehension stage.

Preparation phase: Researchers come to complete the script preparation. Researchers prepare scripts related to the content of this topic and the industry related to this major in advance, and several different roles should be set in the script, and there should be strong conflicts between the roles. A large proportion of students majoring in design in our school will be engaged in design and planning in the future. Based on the reasons for the development of regional and relevant national policies, they will be more inclined to the development of Chinese rural economy and tourism by local college students. Therefore, in combination with the real case of the current cooperation of the college, the batik cultural creation project case in Malipo County, Wenshan Zhuang and Miao Autonomous Prefecture of Yunnan Province is selected for role play. Role preparation: students mainly discuss in groups, analyze characters, understand the characteristics of the industry and solve conflicts. In this case, the researchers designed four personas -2 Malipo village representatives, 1 designer, l village director, and 1 tourist. Divide the students into 5 groups and play a role. Each group also selects a team leader to organize discussions, research scenarios, and dialogues among group members based on several questions designed by the researchers. The basic questions provided mainly include the following contents. The questions of villagers include: The villagers of Tuwang Village require to improve their income through tourism. There is also the bottleneck of the unpopularity of the main handicrafts in the village. Villagers usually need to do farm work and do not have a lot of time to participate in manual production. Villagers hope that products can be close to the lives of villagers. The village director's questions mainly included: How long is the product cycle? How much

does it cost? How much will the villagers get? How does the product attract visitors? Tourists' questions focus on: why does this cultural and creative product attract me? I don't think the product design is creative enough for me to pay for it.

(2) Guidance stage: In the process of role discussion in groups, researchers can provide appropriate help to students, tell them about the professional nature and job requirements of relevant industries, and help them collect and sort out relevant subject knowledge. The researcher is not only guided during the group discussions, but can also intervene throughout, coordinating each stage of the role play.

(3) Play stage: After group discussion and moderate guidance from researchers, each group will present their own results. That is, each group sent representatives to play the corresponding role. In the process of student performance, the researchers appropriately adjust the student activities according to the development of the plot, guide the whole plot to develop along the predetermined teaching direction of cultural and creative products, and receive the expected teaching purpose. During the whole performance, each group of students quickly entered the corresponding roles. In order to reproduce the scene more realistically, students even made simple arrangements and props with paper.

(IV) Evaluation phase: Researchers can ask students to give an evaluation of the performance of each role after a stage of the performance. Each student is required to carefully observe their own actions and those of others, as well as the effect of their actions on others. This link is very important for the whole role play. Only through discussion and evaluation can we find problems, solve problems, and achieve the expected teaching effect.

(5) Comprehension stage: This stage is the sublimation stage of the whole role play. After the end, the researchers showed the processing process of the real case to the students for comparison, so that the students could have a deeper understanding of

what the gap between themselves and the realization was. To promote the final landing and formation of products faster.

Conclusion

1 Through simulation exercises, students delve into the complexity of batik product design in simulated real-world scenarios. They demonstrate the ability to think creatively, adapt to constraints, and collaborate to produce innovation.

2 By playing different roles in small groups, students gain valuable insights into the different perspectives involved in the design process, enriching their understanding of the complexity of a product from concept to implementation.

Evaluation

1: The evaluation index is to submit the role-play evaluation form for each group.

2: Ask students to share their thoughts on the simulation experience, including what they learned, any challenges they faced, and how they would approach the design process differently in the real world. How much interaction they had through "persona" questions.

Role-play evaluation form						Suggestions
Performance completeness (20)					5	
Body language (10)						
Teamwork (10)						
Pronunciation & tone (20)						
Grammar accuracy (20)						

Section 7 Development of outcome through new Idea. -----Generate iterations through training plan projects

Concept

As expressed by(Smith and Eppinger 1997), is that understanding iteration is fundamental to improving and accelerating product development, as well as projects in other domains。 Iteration is a fact of life in any project. (Mihm et al. 2003; (Braha and Bar-Yam 2007).The importance of iteration is well recognized in design and product development research, as well as other disciplines such as software and construction(Wynn and Eckert 2017). practitioners and academics suggested that experts believe ‘‘iterative’’ is amongst the most important characteristics of the design process (Maier and Störrle 2011).

It follows that design, development, and other projects inevitably involve iteration. Iteration has a positive impact, iteration is to achieve the progressive generation of knowledge, to achieve concurrency, and to integrate the necessary changes. Therefore, iteration is an important issue in practice.Iteration does not only involve development of the design, but also monitoring, self-reflection, and control of the design process. (Adams and Atman 2000).

In this activity design, the researchers focused on the process of design and problem solving, showing the iteration between the basic activity types. This iteration is manifested in the macro level by guiding the writing of the innovation and entrepreneurship training plan for college students, formulating specific plans, clarifying the goals, tasks, deliverables and budget of each iteration cycle. Iteration planning allows the team to keep the project organized and ensure that it produces valuable outputs. Combined with the actual situation of Chinese universities, this method can effectively improve the success rate and innovation of the project.

Students: Third year undergraduate students (Experimental group)

Objective

1. To training students' ability of reflection and improvement using iterative method in the process of project development through guiding and participating in the innovation and entrepreneurship training program for college students.

2. The practical operation of students is emphasized through the activity design. Students can gain practical experience through the writing and mutual evaluation of real project books.

Time :120minutes

Learning Materials:

1 Blank version and demonstration version of college students' innovation and entrepreneurship project plan

2 Multimedia Classroom

1 Step/Learning Process

The researchers first introduced the college students' innovation and entrepreneurship training program. "College students' innovation and Entrepreneurship Training program" is a project approved by the main management department of education for undergraduates and is also one of the key construction projects of "Undergraduate Teaching quality and teaching reform Project in Colleges and universities". The purpose is to carry out the reform of innovation and entrepreneurship education, promote the change of talent training concept, improve the quality and ability of college students' innovation and entrepreneurship, and promote the improvement of college students' innovation and entrepreneurship literacy and ability.

Secondly, the students were divided into five groups, and the researchers explained and organized the students to fill in the specific application contents of the innovation and entrepreneurship training program for college students.

Thirdly, the students' innovation and entrepreneurship training programs completed by each group were collected for mutual evaluation.

2 Learning Activities Process

2.1 Researchers first introduced the college students' innovation and entrepreneurship training program. "College Students' Innovation and Entrepreneurship Training Program" is a project approved by the main management department of education for undergraduates and is also one of the key construction projects of "Undergraduate Teaching Quality and Teaching Reform Project in Colleges and Universities". The purpose is to carry out the reform of innovation and entrepreneurship education, promote the change of talent training concept, improve the quality and ability of college students' innovation and entrepreneurship, and promote the improvement of college students' innovation and entrepreneurship literacy and ability. The students asked that they were unfamiliar with the application content of the College students 'innovation and entrepreneurship training program and did not know how to carry out it. Next, the researchers show a complete and more standardized application for college students' innovation and entrepreneurship training program to circulate.

2.2 The researchers sent the blank application form of the innovation and entrepreneurship training plan for college students to the five groups of students and asked them to raise questions. According to the current project book, the researchers asked each group to put forward the unclear parts in the current project book and summarized them for unified answers.

2.3 After getting the questions, the researchers explained how to apply for funding for the project application. The application of innovation and entrepreneurship training program with batik cultural and creative products as the main content is extended. The introduction of the project, research purpose, research content, research status and development trends at home and abroad, innovation points and project characteristics, technical route, problems to be solved and expected results, project research schedule, existing basic writing methods and norms are expounded. Students are required to complete the application for the batik culture and innovation training program for college students.

2.4 After determining the project theme, each group of students divided labor to write the items of the project plan. In the process of writing, students could discuss and interact with each other, and the team atmosphere was good. After writing, the team leader will coordinate the inspection content and submit it to the researchers.

Conclusion

1. The innovation and entrepreneurship training program for college students is an effective way to develop of outcome through new Idea, which enables students to gain practical experience.

2. The students' critical reflection and improvement ability are cultivated. To enable students to understand the value of continuous improvement and adaptation in real-world projects.

3. Dynamic features that promote student creativity, improve project success, and allow students to manage and develop projects.

Evaluation

1. Through the quality assessment of the college students' innovation and

entrepreneurship training plan project books of each group, including clarity, feasibility, creativity and integrity to judge.

2. Teacher observation by observing class participation and monitoring and recording the degree of student participation in class.

Application form of innovation training program for college students

项目编号：

项目名称：

项目负责人：

联系电话：

所在学院：

学　　号：

专业班级：

指导教师：

E-mail：

申请日期：

起止年月：

云南艺术学院

一、 基本情况

<table>
<tr><td>项目名称</td><td colspan="6"></td></tr>
<tr><td>所属学科</td><td colspan="2">一级门类：</td><td></td><td colspan="2">二级门类：</td><td></td></tr>
<tr><td colspan="4">□是否参加“互联网+”大学生创新创业大赛</td><td colspan="3">□是否为青年红色筑梦之旅项目</td></tr>
<tr><td>申请金额</td><td colspan="2">元</td><td colspan="2">起止年月</td><td colspan="3">年 月至 年 月</td></tr>
<tr><td>负责人姓名</td><td></td><td>性别</td><td></td><td>民族</td><td></td><td>出生年月</td><td>年 月</td></tr>
<tr><td>学号</td><td colspan="2"></td><td>联系电话</td><td colspan="4">宅： 手机:</td></tr>
<tr><td>指导教师</td><td colspan="2"></td><td>联系电话</td><td colspan="4">宅： 手机:</td></tr>
</table>

负责人曾经参与科研的情况					
指导教师承担科研课题情况					
指导教师对本项目的支持情况					
项目组主要成员	姓名	学号	专业班级	所在学院	项目中的分工

二、 立项依据（可加页）

（一） 项目简介

（二） 研究目的

（三） 研究内容

（四） 国、内外研究现状和发展动态

（五） 创新点与项目特色

（六） 技术路线、拟解决的问题及预期成果

（七） 项目研究进度安排

（八） 已有基础

1. 与本项目有关的研究积累和已取得的成绩

2. 已具备的条件，尚缺少的条件及解决方法

三、 经费预算

开支科目	预算经费（元）	主要用途	阶段下达经费计划（元）	
			前半阶段	后半阶段
预算经费总额				
1. 业务费				
（1）计算、分析、测试费				
（2）能源动力费				
（3）会议、差旅费				
（4）文献检索费				

2. 仪器设备购置费				
3. 实验装置试制费				
4. 材料费				
学校批准经费				

四 指导教师意见

导师（签章）：

五 院系大学生创新创业训练计划专家组意见

专家组组长（签章）：

六 学校大学生创新创业训练计划专家组意见

负责人（签章）：

七 大学生创新创业训练计划领导小组审批意见

负责人（签章）： 年 月 日

Section 8 Implement results-----Use display to test the implementation of new outcome

Concept

Innovative thinking involves not only generating creative ideas, but also implementing those ideas effectively to bring about tangible results or solutions. The concept of implementation in innovative thinking refers to the process of translating innovative ideas into practical actions, strategies, products or services to meet an identified need or opportunity. Here's how I understand implementation in the context of innovative thinking: First, actionable planning: Implementation involves developing an actionable plan or strategy to turn an innovative idea into reality. And provide students with a physical form to express ideas in a presentation. Students present their projects in a commercially attractive way by participating in events. This activity will take place in outdoor public Spaces or other platforms such as exhibition halls. Team presentations (emphasizing innovative aspects of product outcomes) and convincing audiences, including industry professionals, mentors, and possibly other stakeholders, of the commercial appeal (feasibility of implementing new improvements). Second, stakeholder engagement: Implementation involves engaging stakeholders throughout the innovation process, including end users, customers, partners, and organizational leaders. By soliciting input, building support, and fostering collaboration, innovators can align their implementation efforts with stakeholder needs and expectations, increasing the likelihood of adoption and success. Innovators must develop strategies to scale,

replicate, or adapt their solutions for different contexts, taking into account factors such as scalability, affordability, and environmental impact. Implementation is a key component of innovative thinking as it Bridges the gap between ideas and impact, turning creative visions into tangible outcomes, driving positive change and creating value for individuals, organizations and society.

Students: Third year undergraduate students (Experimental group)

Objective

1 Students are able to develop the ability to demonstrate innovative products to the real world through collaboration with external stakeholders and develop commercial attractiveness.

2 To help students develop actionable abilities to bridge ideas and influence and translate creative visions into practical outcomes.

1. To enhance their collaboration skills and understanding of the practical application of academic knowledge.

Time :120 minutes

Learning Materials:

Presentation materials (e.g. posters, prototypes, slides)

Display material

1 Step/Learning Process

The school will first connect with stakeholders and cooperate with the batik Trading market to hold a public exhibition at the batik Trading market. Students are invited to display all batik prototypes, and relevant industry professionals, tutors, and major businesses are invited to participate. Students prepare live presentations to demonstrate innovative solutions for batik products.

2 Learning Activities Process

2.1 The researcher first organized a demonstration in collaboration with the batik buying and selling market, where the student team presented their project to a panel of stakeholders, including industry insiders, mentors and other stakeholders.

2.2 On the day of the event, students will prepare exhibits and materials and arrange them in the designated area of the market. While waiting for relevant personnel to enter, students hold products to interact and communicate with customers. Student presentation preparation then begins, highlighting the innovative aspects and commercial appeal of their product projects. Students practice public speaking and presentation skills, ensuring that they can confidently communicate their ideas to an audience.

2.3 Demonstration and evaluation. Judges evaluate projects based on criteria such as feasibility, creativity, impact and commercial potential.

Conclusion

Through collaborative presentations with stakeholders, students gain valuable experience in turning ideas into actionable results that are commercially attractive. By connecting directly with the batik buying and selling market, it demonstrates the ability to identify real world needs or challenges, develop innovative solutions, and effectively communicate ideas to a wider audience. The experience enhanced their collaboration skills and understanding of the practical application of academic knowledge.

Evaluation

1 Innovation and creativity: Assess the degree of innovation and creativity shown in the project as well as originality and uniqueness.

2. Commercial attractiveness and feasibility: Measure the commercial attractiveness and possibilities of the project. Evaluate the potential market demand for

proposed solutions and their feasibility in terms of implementation and scalability. Consider factors such as cost-effectiveness, sustainability, and compatibility with existing technology or infrastructure.

3. Impact and sustainability: Consider the long-term viability and scalability of batik products and their potential to create positive social, environmental or economic outcomes.

Section 9 Realize added value--- Adoption of new outcome

Concept

In the context of innovative thinking, the concept of adoption refers to the process by which an individual, organization, or society accepts an innovative idea, practice, technology, or solution and integrates it into everyday life, processes, or behaviors. Adoption is a critical stage in the innovation journey, as it determines the degree to which an innovation is successfully implemented and produces the desired results. First, user acceptance, adoption involves gaining acceptance and buy-in from stakeholders who will be affected by the innovation. Second, scalability and accessibility drive adoption by ensuring that innovative solutions are scalable, accessible, and easy to implement across different environments or user groups. Innovators must design solutions with scalability in mind, removing barriers to adoption such as complexity, cost, or compatibility issues, and ensuring accessibility for different users. Adoption is a key determinant of the success and impact of innovative thinking, as it turns creative ideas into practical benefits and fosters continuous innovation and improvement. By understanding the factors that influence the adoption and implementation of strategies to foster acceptance and integration, innovators can maximize the likelihood of widespread adoption and the full potential of their innovations. Through whether the work is applied for copyright or patent, to achieve the acceptance and recognition of

innovative products.

Students: Third year undergraduate students (Experimental group)

Objective

1: To help students build awareness within the broader context of innovative thinking and innovative ideas, practices, technologies or solutions to ensure that this novelty is widely accepted and integrated into everyday life, processes or behavior.

2: To enhance students' legal awareness to clearly establish the ownership and originality of innovation. This legal recognition helps build trust among users, stakeholders and potential investors, making it easier for them to accept innovative solutions and integrate them into processes or products.

3: Students possess quality and authenticity that can be used in different contexts. Copyright protection helps maintain the integrity of the work, ensuring that any adaptation or modification remains true to the original vision and purpose of the innovation.

Time :120 minutes

Learning Materials:

1 Multimedia Equipment

2 Students batik works

3 Copyright law books

1 Step/Learning Process

The researcher first introduced the basic information about copyright application to the students and explained copyright law and copyright application process. Step 2: Guide students to fill in the online application for copyright until everyone completes the online application submission successfully.

2 Learning Activities Process

2.1 Copyright Introduction

In the multimedia classroom, researchers begin with an overview of what copyright is, its historical background, and its importance in protecting intellectual property. Emphasis on key terms and concepts.

2.2 Understand copyright law

The researchers delve into the details of copyright law, including what is protected, the rights of copyright owners, and the limitations of copyright.

2.3 Copyright application Process

The researcher Outlines the steps involved in applying for copyright, from creating the work to filing an application with the appropriate national or international body.

2.4. Practical operation of copyright application

Students are asked to photograph and archive their work electronically, with high resolution and clarity. And open the multimedia website to guide students to the relevant website to submit the application online. The researchers instructed everyone to open the official website of the Copyright Office of Yunnan Province, prompting you to log in and register to enter the application page, and apply step by step.

Conclusion

Students successfully complete the copyright application process, demonstrating their ability to combine innovative concepts with practical applications. This highlights not only the importance of innovation in driving continuous improvement and development, but also the critical role of the legal framework in ensuring that innovation is recognized, protected and used ethically.

Moreover, practical experience using multimedia tools and applying for copyright underscores the relevance of technological fluency in the modern innovation arena. By navigating these processes, students not only develop a thorough understanding of copyright law, but also hone their skills in using digital platforms to preserve and disseminate creative works.

Evaluation

By collecting pass rates for copyright in works, ensure that students understand the copyright application process not only in theory, but also what it means in practice and the key role it plays in the creative industries and beyond.

Section 10 Review and reflection

Concept

The training terminates with the formation of students' innovative thinking. Opportunities are provided for students to reflect, reflect and summarize. This stage of review and reflection is a critical moment for students to internalize what they have learned, assess their progress, and identify key points from the entire creative thinking process. Innovative thinking is an indispensable core ability in students' study and life. The 5 major steps of a project-based learning model that will observe, generate ideas, experiment and implement, adopt a facilitating process. Engaging in reflective learning can consolidate students' understanding of the concepts covered and consider how they can be applied to their applicability in future endeavors. This process ensures that innovative thinking is not just an abstract skill, but a practical tool that students can apply in the real world, thereby contributing to their continued growth and development.

Students: Third year undergraduate students (Experimental group)

Objective:

1. To develop self-awareness through reflective learning that encourages students to reflect on their experiences, challenges, and growth throughout the lesson plan.

2. To provide structured opportunities for students to consolidate their understanding of innovative thinking concepts and their application to real-world Settings through project-based learning models.

3. To guide students to identify and articulate the most important lessons and insights gained from the entire learning process.

TIME ： 120minutes

Learning Materials:

1 Writing materials (e.g. notebooks, pens)

2 Self-assessment form, peer assessment form, teacher evaluation form

1Step/learning progress:

The researcher explained to the students that this stage mainly includes three parts: reflection writing practice, sharing, and summarizing key concepts. And carry out learning activities according to these three stages.

2 Learning Activities Process

2.1 Reflective writing exercises

Instruct students to spend some time individually throughout the lesson plan to reflect on their learning journey. Students begin to share initial ideas from the first lesson and reflect on how their understanding and perspectives on innovative thinking have evolved. The researchers provided prompts to guide their reflection. Specific questions were as follows:

1. What was the most challenging part of the lesson plan for you?

2. How did you overcome the obstacles and setbacks you encountered along the way?

3. What is the most important insight or lesson you have learned about creative thinking?

4. How do you think you will apply the concepts and skills you have learned in

future projects or situations?

2.2 Sharing

Arrange for students to present their final project or a solution they have developed for a real-world problem. This both echoes the project-based learning model introduced in the first lesson and allows students to demonstrate their growth in innovative thinking.

2.3 Summarize key concepts

The researcher begins with a summary of the key concepts covered throughout the lesson plan, using presentation materials to highlight specific techniques, strategies, and skills that students develop or refine during the course, emphasizing the practical significance of these concepts in promoting innovation and problem solving in a variety of situations.

Conclusion

The summary and reflection phase of the lesson plan provides students with a valuable opportunity to consolidate their learning, reflect on their experience, and identify key points from the entire creative thinking process. By engaging in reflection and discussion, students deepen their understanding of the concepts covered and gain insight into their growth and development as innovative thinkers.

Evaluation

1 Assess students' reflective writing exercises and participate in discussions to assess their understanding and application of innovative thinking concepts.

2 Student activity performance assessment, assessing student performance and growth of innovative thinking. Includes self-assessment, peer assessment and teacher assessment components.

3 The researchers collected student feedback on the curriculum, focusing on students' perceptions of the effectiveness of Project-Based Learning models.

Self-evaluation Form: A journey to reflect on innovative thinking

Student Information:

Name: _____

Date: _____

Instructions:

Take time to reflect on your experiences, learning, and growth in the creative thinking process. Your honest feedback will help me understand how the lesson plan affects your understanding and application of innovative thinking concepts.

Reflect on the question:

1. Challenges encountered:

- What was the most challenging part of the lesson plan for you?

- How did you overcome the obstacles and setbacks you encountered along the way?

2. Key knowledge:

- What is the most important insight or lesson you have learned about creative thinking?

What creative thinking techniques or strategies do you find most effective or impactful? Why?

3. Application in real environment:

- How do you think you will apply the concepts and skills you have learned in future projects or situations?

Can you provide some concrete examples of how you've used innovative thinking to solve a real-world problem or challenge?

4. Teamwork:

- Reflect on your experience working in a group or team throughout the course plan.

- What are your strengths as a team player? Are there any areas for improvement?

5. Future Plan:

- How do you plan to continue to develop your creative thinking skills outside of this course plan?

Are there any specific goals or projects you would like to pursue using innovative thinking skills?

6. Overall reflection:

- What do you find most valuable or enjoyable in the process of creative thinking?

- Do you have any other experiences or insights you'd like to share?

Peer evaluation form: Reflecting on the experience of collaboration

Student Information:

Name: _____

Date: _____

Instructions:

Please take the time to provide constructive feedback to your colleagues based on your experience collaborating throughout the creative thinking process. Your

feedback will help each team member understand their strengths and areas for improvement, fostering a culture of continuous learning and growth.

Peer evaluation questions:

1. Contribution to the team:

Do team members actively participate in group discussions and activities?

-How effectively do team members communicate ideas and contribute to the overall collaborative process?

2. Leadership and initiative:

Do team members demonstrate leadership qualities or take the initiative to guide the team to achieve its goals?

How well do team members manage tasks and responsibilities within the team?

3. Creativity and Innovation:

-Did the team members contribute creative and innovative ideas to the project?

How effectively do team members apply innovative thinking techniques or strategies to solve problems?

4. Adaptability and flexibility:

- How adaptable are team members in dealing with changing circumstances or challenges?

Do team members show flexibility in adapting approaches or ideas based on feedback or new insights?

5. Collaboration and support:

- How supportive are team members of their colleagues' ideas and contributions?

Do team members actively seek feedback and make constructive suggestions to improve the project?

6. Overall Contribution:

-Evaluate the overall contribution of team members to the group project based on your collaborative experience.

-[] Very good

-[] Very good

-[] Satisfied

-[] Needs improvement

Teacher Evaluation Form: Assessing student performance

Student Information:

Name: _____

Date: _____

Instructions:

Each student's performance is assessed based on their participation, engagement and achievements throughout the innovative thinking course. Use the following criteria to assess their personal contribution to the learning process.

Evaluation criteria:

1. Get involved:

- Actively participate in class discussions, activities and exercises.

- Show enthusiasm and interest in the subject.

2. Creative thinking:

- Demonstrate creative and innovative thinking in problem-solving tasks.

Develop unique ideas and approaches to challenges.

3. Collaboration skills:

Work effectively as part of a team and participate in group discussions and projects.

4. Communication skills:

- Express ideas clearly and clearly both orally and in writing.

- Actively listen and engage in meaningful conversations with colleagues and mentors.

5. Adaptability and flexibility:

- Adapt to the changing environment and accomplish tasks flexibly.

Demonstrate resilience in the face of challenges and setbacks.

6. Problem solving ability:

Skilled use of problem-solving skills and strategies.

Proactively seek solutions to complex problems.

7. Quality of work:

- Produce high quality work with attention to detail and accuracy.

- Demonstrate creativity and originality of project results.

8. Overall Affairs:

- Demonstrate sustained commitment and effort throughout the course.

Actively seek opportunities to learn and grow.

Overall evaluation:

Students' contributions in class discussions, group activities and individual assignments are considered comprehensively to evaluate students' performance in the innovative thinking class.

-[] Very good

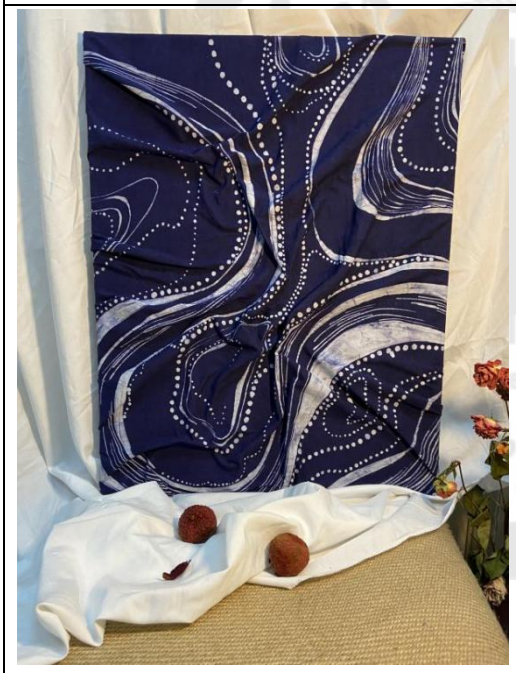
-[] Very good

-[] Satisfied

-[] Needs improvement

Appendix H: Experimental group part of the product display

Experimental group part of the product display



Cultural and creative life, toy products display

Batik installation art products

Cultural and creative degree cap product design

VITA