The Path and Enlightenment of American Project-Based Learning to Promote the Cultivation of College Students’ Innovative Ability

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Abstract. In this new era of fierce international competition, innovation is the motive force of a country’s development, so cultivation of innovative talents is particularly important in this era. The innovative education in the United States is characterised by project-based learning, which plays a prominent role in cultivating innovative talents and has certain reference value. This paper will summarise the outstanding characteristics of PBL in the United States, that is, PBL in the United States is cooperative, practical and autonomous. Universities cooperate with social enterprises. Interdisciplinary ability is of vital significance and PBL emphasises that teachers should pay attention to guidance rather than control the process. At the same time, multiple assessment standards of comprehensive network should be set. PBL focuses on students' independent learning ability. Then the paper summarises the lessons and inspirations brought by PBL innovation education, that is, it pays attention to the cooperation with social enterprises while it has a more reasonable practice setting orientation and sets up a more scientific management system, so as to enhance the innovation ability and international competitiveness of college students in various countries.

1. Introduction

Innovation serves as the impetus behind societal advancement while the cultivation of innovative talents remains a primary focus for nations. Present-day society necessitates university students equipped with creative aptitude who can contribute towards constructing our communities. Project-Based Learning (PBL) stands as a potent pedagogical approach fostering such innovative capacities. These competencies encompass students’ awareness of innovation, teamwork spirit, interdisciplinary abilities, and holistic development, that is to say, students possess innovative ideas employing all available information inclusive of pre-existing knowledge and experience thereby generating distinctively novel products bearing social or personal value through their acquired skillset comprising three integral components namely innovation awareness, innovative thinking, and innovative skills; with innovative thinking being the core.[1] Within this contemporary knowledge era characterised by escalating global competitiveness, internationally speaking, numerous nations grapple with insufficiency concerning student motivation pertaining to social innovations and inadequacies in terms of innovative abilities and suboptimal teaching approaches because these approaches have limited specificity combined with ambiguous target orientations. Plus, their educational concepts are rigid and their teaching methods monotonous and outdated etc., therefore there exist many problems that urgently need to be solved regarding the cultivation of university students' innovation abilities.

Throughout the world, the United States currently possesses distinct advantages in fostering college students' innovation capabilities. Among these, project-based learning (PBL) stands out as a prominent characteristic. This model effectively integrates practical experience with teaching methodologies and places significant emphasis on nurturing students' interdisciplinary skills. Consequently, PBL emerges as a pivotal feature within the realm of innovation education at American universities. Presently, existing literature predominantly focuses on the role of PBL in promoting specific professional competencies, while research pertaining to the impact of American PBL on advancing innovation abilities remains relatively scarce. There exists an insufficiency in terms of systematic exploration and modelling regarding how innovative capacities can be cultivated through PBL among university students in America.[2] Therefore, it is imperative for us to intensify research on how higher education institutions can bolster students' prowess in innovation and explore a myriad of approaches to cultivate the innovative capabilities of college students. This article will primarily delve into examining the role played by American PBL in nurturing innovation abilities.

This article aims to explore the common training methods and approaches of PBL in some American universities, with a specific focus on the project-based learning courses offered at the School of Sustainability at Arizona State University and the paper will extract their distinctive characteristics of projects set up in American PBL, student engagement levels, the
multifaceted roles of teachers, and other features. Additionally, it will analyse the enhancement of innovative abilities among American students during the PBL process and track the subsequent effectiveness of these projects. The findings derived from this study can serve as invaluable references for fostering innovative capabilities through PBL across diverse nations while propelling global diversification in innovation education.

2. The connotation and characteristics of the PBL

The idea of PBL can be traced back to Confucius and Socrates, who employed Socratic questioning to provide students with directions for thinking and encourage independent thinking and exploration. It was not until the 1960s that PBL was officially adopted at McMaster University.[3] Project-based learning entails teachers designing projects based on real-world problems and their educational goals, which students can independently solve. In this process, students have a high degree of autonomy and need to collaborate in teams, while teachers take on the role of facilitators. The cultivation of innovative abilities is both the process and purpose of PBL.

Essentially, the PBL model consists of seven characteristics. Firstly, it focuses on a large, real-world open-ended problem; secondly, it requires students to integrate their existing knowledge and abilities into the process of problem-solving; thirdly, the problem needs to have inquiry significance that can stimulate students’ curiosity and enthusiasm; fourthly, it utilises students’ critical thinking, innovative thinking, communication skills and collaboration abilities; fifthly, it has the characteristic of allowing students to choose according to their individual preferences; sixthly, the solution methods can be repeatedly modified for improvement; seventhly, PBL requires students to present the problem, research process, solution methods and results for evaluation.[4]

The American STEM PBL teaching methodology comprehensively embodies these seven characteristics, encompassing teachers preparing a vaguely defined problem for students in PBL teaching, which necessitates multiple solutions that are explored and discussed by students rather than relying solely on rote memorisation to answer. STEM PBL requires student participation in seven processes, namely the identification of problems and constraints, research, conceptualisation, analysis of ideas, testing, improvement and communication. Afterwards, the teacher will grade them based on the solutions and performances they come up with instead of relying exclusively on papers or fixed knowledge exams.[5]

From this, it can be seen that the openness, freedom, and flexibility of American PBL are beneficial for developing students’ thinking and enhancing their innovation ability. Teachers possess knowledge and understand the process while students learn by doing. Under the guidance of teachers, students actively engage in practical learning. The assessment standards for courses depend on how much knowledge and processes are absorbed and learned by students and so on.[6] The goal is fixed and students need to think flexibly, find countless possible solutions to open-ended problems and acquire indispensable interdisciplinary knowledge and other skills.

3. The cultivation path of college students’ innovative ability promoted by PBL in the United States

3.1. The orientation of cultivation path

Project-based learning is a pedagogical approach wherein educators design problems for their students to tackle, work in groups and conduct independent research and experiments to collect data based on their educational objectives. If students have research problems, the teacher can guide them towards open-ended solutions instead of giving ready-made answers. After students produce practical outcomes, the teacher evaluates them from multiple perspectives and provides constructive feedback and guidance. The process of American PBL simulates the innovation process, where each project serves as an application of innovative thinking by utilising existing knowledge to generate flexible and creative results. Students are granted a significant level of autonomy, and due to the societal significance of their projects and a positive collaborative atmosphere, their motivation is heightened. Their capacity for innovation is nurtured through independent efforts. This aligns more with the concept of innovative ability and better achieves its fundamental goal of cultivating innovative capabilities.

3.2. Elements of the cultivation process

PBL is closely related to four factors: practicality, collaboration, subjectivity, and multi-dimensional assessment. The first factor practicality allows students to feel engaged, helps them understand real-world problems and boosts their motivation for innovation. The second factor collaboration enables students to autonomously divide tasks and work together effectively to enhance their innovative abilities. They autonomously improve skills to achieve innovative goals. The third factor, subjectivity allows autonomous exploration based on existing knowledge and experiences. Student-driven learning gives them more autonomy and fosters creativity, motivation, and the ability to handle pressure, tolerate mistakes and cooperate with others, which has a profound positive impact on future innovative behaviour. The fourth factor is multi-dimensional assessment. Teachers evaluate students’ performance and output of innovative products using various dimensions, not just exams or papers.[7]

According to the above elements of cultivation, it is found that PBL in the United States particularly emphasises rational orientation, which emphasises independent development and integration with the real world. The intervention of facilitators is reduced. Instead, they provide students with more positive feedback and encouragement, believing that every student can succeed.
For research and learning under uncertain factors, teacher affirmation and encouragement hold paramount significance. In this process, students should maintain an open-minded thinking mode, believe in themselves, and actively learn interdisciplinary knowledge. Plus, students will also have various improvements and form a good atmosphere of teamwork where they achieve common goals.

4. The distinctive features and effectiveness of cultivating university students' innovative abilities in the PBL system in the United States

4.1. Cooperation

First of all, PBL is characterised by its cooperative nature between businesses and universities worldwide, where education is closely linked to enterprises. Through PBL, businesses are able to cultivate students' innovative abilities in a coordinated manner. At Arizona State University, PBL has become a regular course because the PBL teaching at the School of Sustainability emphasises connections with professionals from various industries in the real world, thereby enhancing students' communication skills with practitioners.

Secondly, PBL also cooperates with universities in other countries for joint projects and teaching programs. For example, Tokyo University in Japan and Arizona State University in the United States have collaborated on a summer school program where students and teachers work together to solve regional sustainable development issues. International collaboration has also promoted research on PBL in the United States. Most students have expressed that they gained valuable teamwork experience through PBL, improving their communication skills and efficiency, as well as developing cross-industry communication abilities. Compared to other teaching methods, PBL helps them realise the importance of teamwork. Therefore, it can be seen that the cooperative nature of PBL provides a successful paradigm worth learning from and considering.

4.2. Practicality

PBL is practical as it produces real-world solutions and actual products and helps students acquire more practical skills that can be helpful for future employment, while gaining a deeper understanding of the realities of this world. Arizona State University's PBL courses include projects focusing on addressing future water issues for agriculture in Arizona and researching comprehensive sustainable development policies for a specific city. During these projects, students work in teams under the guidance of teachers and professionals in the field. The institution mainly provides relevant professional knowledge and funding for these projects, establishes incentive systems, offers allowances for teachers, pays wages to student teams, and enhances teaching flexibility.[9] Therefore, PBL integrates education with real-world development by combining practice with theory to enhance students' innovative abilities. As a result, students strengthen their problem-solving skills through critical thinking when facing challenges in real-life production scenarios.

In addition, many PBL programs in American universities involve practical cooperation with social institutions and businesses. This greatly benefits the expansion of students' professional knowledge and skills, as well as their social networks. It also enhances their communication abilities, broadens their perspectives, improves their emotional intelligence, resilience, flexibility of thinking, and tolerance for mistakes. The positive collaborative atmosphere among students in PBL also boosts their motivation and sense of social responsibility because they can see the practical application of what they have learned and believe that both their learning and themselves are meaningful to society.

4.3. Autonomy

Project-based learning is characterised by autonomy, and PBL not only requires students to understand and master knowledge but also emphasises the importance of solving real-world problems through autonomous and conscious practice. By independently thinking about solutions, students can fully exert their subjective initiative, enhance interdisciplinary abilities, and ultimately achieve the goal of flexibly applying knowledge. [9] At Arizona State University, PBL itself is integrated into regular courses. In the classroom, every task assigned by teachers requires students to think about the real world actively and autonomously. This not only requires students to combine knowledge, skills, attitudes, and strategic thinking for innovative thinking but also provide comprehensive sustainable development plans.

Throughout the entire thinking process, PBL does not set a standard answer, which means that students have a certain degree of freedom and autonomy. PBL values the dynamic and open exploration process, in which teachers fully respect the student's subject position. Therefore, students can flexibly apply their knowledge and abilities within a relatively free framework. This is also a necessary process for improving innovation ability. Because they break through known boundaries and freely imagine creative solutions. As such, students' innovative ability and subjective initiative are enhanced during the PBL process.

In conclusion, PBL in American universities has corresponding characteristics in terms of application paradigm, teaching philosophy, and individual orientation. The cooperation, practicality, and autonomy followed by this approach all point to the core competence of students' innovative abilities. Therefore, this type of model has achieved successful experiences and results, which is worth learning from.
5. Reference and inspiration

There are three aspects to draw inspiration from the PBL model in the United States. Firstly, schools can collaborate with off-campus companies or organisations. Since the 19th century, individuals have had to integrate into impersonal and rational structures based on functions, rules, and regulations. Companies or organisations can propose their own urgent problems to be solved and set them up as PBL projects. Students can choose topics they are interested in and during the process, students enhance their interaction and communication with businesses while gaining practical work experience in society. Appropriate incentive mechanisms should also be established to create an academic atmosphere that encourages competition and innovation, thereby increasing students' enthusiasm for participating in PBL. This requires schools to establish some reward mechanisms by enacting regulations that award PBL innovative education, such as scholarships. Schools should increase the proportion of funding invested in PBL innovative education and sources of funding could come from sponsorships by social enterprises and organisations. Additionally, schools should improve infrastructure related to PBL innovative education by establishing advanced laboratories for physics, medicine, chemistry, etc., which provide hardware support for students' innovative research and development efforts.

Secondly, the American PBL has a more reasonable practical setting orientation for cultivating college students' innovation ability. Therefore, PBL in various countries can learn from its characteristic of being set in the background of the real world and concentrate on projects with social significance, such as local sustainable agricultural water usage issues or solving local production problems, emphasising that students can bring tangible improvements through PBL and enhancing their sense of social responsibility. The American PBL also values interdisciplinary knowledge by setting projects that require cross-disciplinary knowledge, thus students' perspectives will not be confined, and their innovation ability as well as other abilities will be cultivated, such as literature retrieval skills, information searching abilities, self-directed learning abilities, etc. Students apply this knowledge to solve real-world problems with their subjective initiative. For example, exploring ways of wastewater treatment in a factory's sewage discharge into rivers integrates knowledge from geography, physics, chemistry, and other disciplines. In addition to the aforementioned points, it is also necessary to promote students to form a collaborative community. On one hand, this enhances their teamwork spirit; on the other hand, it strengthens their level of brainstorming ideas and broadens problem-solving strategies so as to achieve practical application value.

Finally, schools should establish a more scientific and reasonable management system to create an autonomous and equal teaching environment. Firstly, this includes setting scientific evaluation criteria that emphasise teachers' comprehensive perspective on students, considering factors like progress, teamwork, and interdisciplinary knowledge integration. Teachers should fully trust students' initiative, encourage them to demonstrate their autonomy and innovative abilities, and approach teaching with a positive mindset believing in the success of every student which also serves as encouragement for the students themselves. Projects should be designed in an open-ended manner rather than being yes-or-no questions because open-ended questions can guide students towards creative thinking and generate multiple solutions. Teachers should advocate for equality by encouraging critical thinking among students who dare to question authority or raise valuable doubts. Creating an equal cultural environment like this is conducive to fostering a free academic atmosphere which is essential for innovative activities.

6. Conclusion

Based on the above analysis, PBL in the United States have strong autonomy and is closely integrated with the real world, testing students' interdisciplinary ability and interpersonal communication skills. When setting up PBL projects, countries other than the United States can also collaborate with off-campus companies or foreign universities, closely integrating students with the real world. Projects can also be designed to test students' autonomous abilities in cross-disciplinary knowledge and sufficient funding and infrastructure ought to be provided to support students. Furthermore, universities should lay emphasis on projects' openness and reduce teacher intervention to cultivate more innovative talents with strong comprehensive abilities and interdisciplinary knowledge in the future.

References


