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Exploration of Task-driven Project-based Teaching in Innovative Talent Development

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Abstract: In China, there's a growing emphasis on cultivating students' critical thinking and lifelong learning abilities during the foundational stages of education. In response to the national imperative for cultivating top innovative talents, Beijing No.10 Middle School has initiated reforms in classroom instruction. A primary approach involves adopting a project-based teaching methodology. Through discussions and data analysis, it has been observed that under the guidance of project-based teaching, students demonstrate significant improvements in their critical thinking and various other performance indicators. Beijing No.10 Middle School aims to garner more attention from scholars both domestically and internationally, with the goal of enhancing the overall quality of education at the institution.

Keywords: Innovative Talent Development; Task-driven Project-based Teaching

1. Research Background

In some countries, research on creativity and the cultivation of innovative talents began relatively early. For instance, from the 1950s to the 1970s, constrained by the outcomes of divergent thinking studies, creativity mainly focused on the individual level. By the 1980s, there was a greater emphasis on cultivating complex skills in creativity and innovative talent development. Towards the end of the last century, research into systematic models for cultivating innovative talents emerged, primarily focusing on two aspects: firstly, enhancing students' innovative spirit and practical abilities, and secondly, integrating the cultivation of innovative qualities with the talent development models of universities.[1].

In China, the transition from individual-based cultivation of complex skills to comprehensive innovation-oriented talent development has been gradually unfolding. At the national level, strategic tasks such as "enhancing the overall quality of independently cultivated talents, focusing on fostering top innovative talents, and gathering talents from around the world for national development" have been deployed. This presents a more challenging task for the entire education system while also bringing significant development opportunities. Strengthening the independent cultivation of top innovative talents should be an essential aspect of China's education modernization and an inherent requirement for the high-quality development of education.

2. Theoretical Basis

The term "top talent" traditionally refers to the top 1% to 5% or even smaller portion of the population, depending on the definition of "intelligence" or "wisdom" within different paradigms. It denotes excellence in physiology and innate abilities, often referred to as "intellectual excellence, " with the group typically scoring above 132 on IQ intelligence tests and demonstrating innate linguistic and cognitive talents. It is imperative to acknowledge the existence of these exceptional individuals, recognize their critical strategic value, and not overlook their individual pursuits and value preferences. It's essential to effectively identify, unearth, and harness the immense potential of this group. With 290 million students enrolled in schools across China, even with a conservative 1% identification threshold, the population of intellectually talented students approaches 3 million, with a national total, including adults, reaching 14 million. It's crucial to conduct precise calculations considering school geographical locations, demographic characteristics, etc., to understand the basic reservoir and distribution of this special human resource, establish a clear understanding of their growth potential and probability of success, develop a sound and scientific identification and assessment system, and innovate mechanisms and pathways for talent development. Based on the foundation of cultivating virtue and nurturing talents, systematic educational practices should be carried out according to the laws governing the growth of top innovative talents and educational principles.

Project-based learning aims to start with students' interests, address real-world problems, and enhance students' core subject competencies through tasks design, intrinsic motivation, project progression, problem exploration, and resolution. Ultimately, this approach fosters the

discovery and cultivation of top talent. We believe that if a student can successfully engage in comprehensive project-based learning, they must possess a broad knowledge base, strong analytical abilities, well-rounded subject competencies, and a proactive innovative spirit.

3. Exploration of the Beijing No.10 Middle School Model

Project-based learning has been implemented in the junior middle school section of the Beijing No. 10 Middle School Education Group for nearly two years. Mathematics, physics, chemistry, biology, and geography were the first five subjects to be gradually extended to other subjects, and now nine subjects have implemented project-based learning. What is the effect of project-based learning on the development of students' core competencies from a student perspective? What is the role of project-based learning in promoting the transformation of the way schools educate students? The following will combine the "evaluation data" provided by Beijing Normal University's Innovation Research Institute to analyze the development and implementation effects of project-based learning, and explain the effects of project-based learning on the development of students' core literacy and its role in promoting the transformation of school education methods.

Beijing Normal University's Institute of Chinese Education Innovation conducted a follow-up evaluation on schools in Beijing Fengtai District that implemented project-based learning for the 2021 first-grade junior middle students (experimental group) and those that did not (control group). The data in the report spans from the academic year 2021 to 2022. During this period, Beijing No. 10 Middle School introduced project-based learning in mathematics, biology, and geography for the first-grade junior middle students, with project-based learning in its initial stages. The evaluation data provides crucial guidance on the implementation and effectiveness of project-based learning at the initial stages in Beijing No. 10 Middle School.

3.1 Implementation of Project-based Learning - Effective Implementation in the Initial Stage

Project implementation evaluation result: The overall score of the Beijing No.10 Middle School project-based learning activities has reached the average level of Fengtai District. See Figure 1 for an explanation of the overall quality score of Beijing No. 10 Middle School and Fengtai District project.

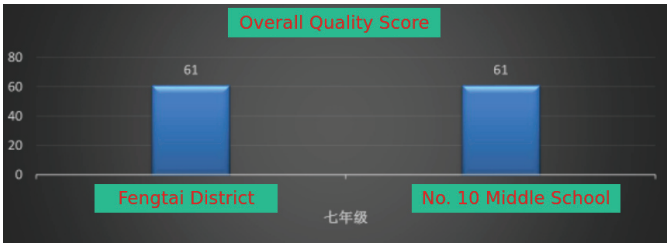

Figure 1 Explanation of Overall Quality Score for Beijing No. 10 Middle School and Fengtai District Project.

Table 1 Project-Based Learning Survey

Question	Beijing No.10 Middle School	Area average
Difficulty level of problems in project-based learning (problems are moderately challenging).	87%	85%
Project-based learning is closely related to real life (problems that are closely related to life or have a certain relationship).	58%	61%
Problem posing in project-based learning (students posing under teacher guidance)	77%	79%
Research problem identification (student determination under teacher guidance)	88%	87%
Do you hope that the school will continue to carry out project-based learning?	78%	73%

Based on the evaluation data on implementation, Beijing No. 10 Middle School is at the average level among experimental schools in Fengtai District. Following project-based teaching, Beijing No. 10 Middle School conducted a survey on project-based learning issues, as shown in Table 1. Despite most teachers lacking experience in implementing project-based learning, over 70% rated the "difficulty level of project-based learning, and problem identification and formulation" as satisfactory, indicating the effectiveness and overall adequacy of expert and research guidance, and demonstrating a promising start for project-based learning. The effectiveness rate in terms of "relevance to real life" was slightly lower. Encouragingly, in response to the question "Do you want the school to continue implementing project-based learning?", our school's affirmative response rate exceeded the district average by 5 percentage points, with 78% indicating most students welcome this teaching method. This represents the best reward for pioneering efforts in practicing project-based learning, reinforcing our confidence in implementing it effectively. The data on implementation indicates the effectiveness of project-based learning at its initial stages and confirms the credibility of the implementation outcome data.

3.2 Project-based learning implementation effect - improving students'core literacy and developing students' innovative thinking

The evaluation results on the impact of student core competency development (see Table 2):

Table 2 Core Literacy Assessment Results

Core Literacy	Comparison of improvement magnitude with control group.
Cultural Understanding and Inheritance	Higher than
Adjudication literacy	Higher than
Innovative literacy	Significantly higher than
Communication skills	Significantly higher than
Collaboration skills	Significantly higher than
sense of social responsibility	Hold steady
Resilient quality	Higher than
Curiosity	Hold steady
Mathematical modeling ability	Below
Scientific problem-solving ability	Significantly higher than

3.2.1 Overall effect

Seven aspects of literacy are higher than the control group, two aspects are the same as the control group, and one aspect is lower than the control group. From the overall evaluation data results, it can be seen that project-based learning has a positive effect on the development of students' core literacy. The progress in innovative literacy, communication literacy, collaboration literacy, and scientific problem-solving ability is significantly higher than that of the control group, which further demonstrates the significant role of project-based learning in developing students' core literacy. This has strengthened the confidence of Beijing No.10 Middle School in continuing to carry out project-based learning and will further promote its implementation in middle school.

3.2.2 Reflection on "Maintaining a Sense of Social Responsibility"

After a year of junior middle school learning and two project-based learning processes, students' sense of social responsibility has not been significantly improved, which requires us to seriously reflect on it. Social responsibility is one of the key qualities of a healthy personality and a core aspect of the social development of young people. It is an essential quality for young people as the successors of our socialist society, and it is also a key competence for schools to fulfill the fundamental task of cultivating moral character and nurturing talents.

During the evaluation period, the first-grade students engaged in three project-based learning activities: "Improving Home Waste Bin Design for Garbage Classification" in Mathematics, "Creating a Popular Science Manual on Invertebrates" in Biology, and "Survey and Recommendations on Morning Rush Hour Traffic Congestion on Zhoukoudian Road" in Geography. In terms of the number of projects undertaken, the impact on enhancing students' sense of social responsibility was limited. Additionally, there was a lack of detailed design to fully harness the potential of project-based learning in cultivating social responsibility. For instance, due to the pandemic, the Mathematics project shifted from "campus waste bin classification" to "home waste bin classification, " restricting students' activities to their homes and diminishing the project's spatial advantage. Furthermore, the focus of learning was predominantly on data recording, knowledge application, and poster production, with insufficient guidance on the importance of waste classification or analysis of the social significance behind the data. The project failed to extend beyond designing home waste bins to include recommendations and reflection on community waste station placement, thereby not fully realizing its potential to enhance students' sense of social responsibility.

The implementation of project-based learning focuses more on improving classroom teaching methods, emphasizing the presentation of projects on subject knowledge and textbook chapters, but lacks sufficient emphasis on cultivating a sense of social responsibility. Furthermore, at this stage of the project, the focus of learning is mainly on science subjects, with fewer themes related to social and human care. Of course, the most crucial aspect is to start with the design of the project, which should be able to deeply touch the soul of students' values. Taking the "Improvement Design of Family Classification Trash Can" math project as an example, if students are involved in investigating the source of household waste for a week, collecting the waste intuitively and then analyzing the quantity and harm of different types of waste (such as pollution or degradation), and focusing on the economic and commercial value of different waste disposal methods, students can deeply understand the social and economic value of waste classification and reuse. This project will greatly enhance the sense of social responsibility. Therefore, we are looking forward to more projects with social issues, such as "Super Orator - Advocating for Hometown, Cross-cultural Body Language Communication, Plastic Reduction Action, Are You Using Disinfectant Correctly, Tracing the Carbon Footprint, " etc. We

hope that the design of these projects will be more advanced, broad, and profound, so that they can have a greater impact on guiding students' values, emotions, and sentiments.

3.2.3 Exploration of cultivating innovative talents.

At the rise of artificial intelligence, it becomes even more important to develop students' innovation literacy and cultivate innovative talents. Through integrated training, curriculum design, and guidance from renowned teachers, Beijing No.10 Middle School Education Group is actively exploring ways and strategies for early cultivation of top-notch innovative talents. And through project-based teaching, a statistical survey was conducted on the core competencies of innovative talent cultivation for students, as shown in Table 3.

Table 3 Comparison Table of Innovative Talent Development

Core Literacy	Comparison of improvement magnitude with control group.
Curiosity	Hold steady
Critical thinking skills	Higher than
Scientific problem-solving ability	Significantly higher than
Innovative literacy	Significantly higher than

Innovation literacy encompasses innovative personality, innovative thinking, and innovative practice. Curiosity, critical thinking, and problem-solving abilities are all related to innovation literacy. We also need to delve into the factors influencing curiosity, critical thinking, problem-solving skills, and innovation literacy and meticulously design project-based learning. For instance, in the mathematical project "Improving Home Waste Bin Design" by teachers Zhang Li and Monk Yunlong, the textbook chapter "Data" provides examples such as TV program ratings and wheat growth conditions. Obviously, these examples are rarely encountered by students in their daily lives and may fail to resonate with them, leading to passive learning. However, the two teachers combined the topic of "Data" with the improvement of home waste bins, focusing the perspective on items familiar to students, thereby sparking their interest. Moreover, students are required to collect and analyze data themselves, address problems that arise during the learning process, propose different insights, and suggest various problem-solving methods, thus undergoing a process of creative analysis and problem-solving. Similarly, in the biology project "Preventing and Controlling Campus Cotton Seed Flies" designed by teachers Xu Xin and Wang Yaqian, students are encouraged to consider different control methods such as spraying and medications. By creatively selecting knowledge from different angles to address problems and utilizing various methods for problem-solving, students continuously develop their problem-solving skills. Project-based learning effectively enhances students' innovation literacy. In these examples, the projects are highly beneficial for teachers' professional growth as well.

4. Outlook

We hope that teaching driven by tasks and guided by project-based learning will continue to provide more diverse and extensive approaches for cultivating innovative talents. In the past two years, the attempts based on junior middle school curriculum have been successful, and we also hope that in the future teaching process, it can gradually extend to middle school curriculum, and think about the connection and continuity of junior and senior middle school education from the direction of project-based learning. Although we have already tried using project-based teaching in some middle school classrooms to help students develop innovative thinking and creativity (see attachment: lesson examples), we are looking forward to collaborating with schools in Beijing to complete a more systematic project-based learning plan for junior and senior middle school.

The Beijing Middle School Science and Technology Collaborative Group provides us with a broad space for communication. We hope that more schools and teachers can participate and explore the challenges encountered in the process of cultivating innovative talents through task-driven project-based learning. Ultimately, we aim to develop unique teaching characteristics in Beijing and promote them widely.

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