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Effect of Project-Based Learning on Autonomous Learning Ability of Kindergarten Children

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Abstract

Background and Aims: Rooted in constructivist and experiential learning theories, Project-Based Learning (PBL) is recognized as an effective approach to fostering 21st-century competencies. However, China's preschool education faces prominent challenges—overemphasis on cognitive development at the expense of character cultivation, inappropriate curriculum design, and insufficient alignment with young children's developmental needs. Despite PBL's proven value in developing core skills, empirical research focusing on its application in early childhood education remains scarce. Autonomous learning ability, defined as young children's capacity to independently initiate, plan, adjust, and reflect on learning activities driven by intrinsic motivation, is a foundational skill for lifelong learning. This experimental study aimed to: 1) compare kindergarten children's autonomous learning ability before and after participating in Project-Based Learning (PBL); 2) verify whether their autonomous learning ability meets the preset 70% proficiency criterion.

Methodology: The sample of this study comprised 40 kindergarten children from one senior class at the Kindergarten of the Academy of Military Sciences. The sample was selected using the cluster random sampling method. The research instruments included (1) 6 lesson plans using Project-Based Learning with a very high level of appropriateness (overall M=4.6, SD=0.27) and an autonomous learning ability observation form (3-level rubric) (The results of the IOC index showed that the IOC for each item ranges from 0.67 to 1.00). The statistics used to analyze data were mean, standard deviation, t-test for dependent samples, and t-test for one sample.

Results: The results revealed that 1) after using Project-Based Learning, posttest scores of the kindergarten children's autonomous learning ability (M=35.40, SD=2.05) were higher than pretest scores (M=21.65, SD=2.26) at the.01 level of statistical significance (t_{39} = 32.369, p =.000). And 2) posttest scores of the kindergarten children's autonomous learning ability (M=35.40, SD=2.05, full

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score = 45, criterion score=31.5) were higher than the determined criterion of 70% at a significance level of .01 (t_{39}=12.04, $p < .001$)

Conclusion: The five-step PBL instructional process Identify genuine and valuable questions, guided exploration planning, deep exploration and cross dimensional integration, output of achievements and multivariate evaluation, reflection iteration and benchmarking against reality enhances kindergarten children's autonomous learning ability. PBL integrates real-life themes, scaffolded support, and collaborative inquiry, fostering children's initiative, problem-solving skills, and practical application capabilities, providing empirical evidence and practical templates for early childhood education innovation.

Keywords: Project-based Learning (PBL); Kindergarten Children; Autonomous Learning Ability; Early Childhood Education

Introduction

In the context of global educational reform, 21st-century competencies such as autonomous learning, collaboration, and creativity have become core goals of education (Altinpulluk & Yildirim, 2021; Larson & Miller, 2011). Since the mid-1990s, China has promoted quality education reforms in preschool settings, aiming to foster children's holistic development. However, practical challenges persist due to limitations in educational resources, research levels, and public perceptions. A key issue is the misalignment between preschool education practices and children's developmental needs: many kindergartens overemphasize cognitive skills while neglecting the cultivation of autonomous learning, social skills, and emotional regulation (Liang, 2024). For example, a survey by Wang (2013) found that 68% of kindergartens in urban China have curricula that include primary school-level content, leading to cognitive overload and reduced learning motivation among children.

Additionally, curriculum design often lacks localization adaptation. Many kindergartens directly adopt Western curricular models without considering cultural differences and actual teaching conditions, resulting in low implementation effectiveness. Such practices fail to cultivate the 21st-century skills essential for children's future development, including critical thinking, creative problem-solving, and collaborative communication. Against this backdrop, exploring a child-centered teaching model that aligns with developmental characteristics and cultivates core competencies has become an urgent need in preschool education reform.

Autonomous learning ability is particularly crucial for young children, as it supports intrinsic motivation, persistence, curiosity, and the capacity to regulate one's own learning processes (Montessori, 1967; Zimmerman, 1990). From a humanistic perspective, Rogers (1951) highlighted that autonomous learners actively evaluate information, make decisions, engage in inquiry, and

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reflect on their experiences—traits that form the foundation of lifelong learning. Dewey (1916) further argued that autonomy develops through reflective thinking and active participation in meaningful tasks, enabling children to plan simple activities, adjust strategies when facing challenges, and develop habits essential for long-term success (Yu, 2021). As such, autonomous learning serves as a core pillar of 21st-century competencies and overall child development.

Project-Based Learning (PBL) emerged as a promising approach to address these needs. Rooted in constructivist and experiential learning theories, PBL organizes learning around authentic, meaningful projects, encouraging students to engage in inquiry, collaboration, and reflection (Blumenfeld et al., 1991; Thomas, 2000). Unlike traditional teacher-centered instruction, PBL emphasizes child agency, allowing children to explore real-world problems, make decisions, and produce tangible outcomes. Research has shown that PBL enhances students' initiative, practical experience, and collaborative skills in primary and secondary education. For preschool children, PBL's focus on play and hands-on practice aligns with their learning characteristics, making it an ideal method for cultivating autonomous learning ability.

However, existing PBL research predominantly focuses on older students, with few studies exploring its application in kindergarten settings. Most preschool PBL practices are descriptive or case-based, lacking rigorous experimental design and systematic assessment (Maulidah & Abdillah, 2023). There is a critical need to develop age-appropriate PBL frameworks, validate their effectiveness through empirical research, and provide practical tools for frontline educators. This study addresses this gap by investigating the impact of PBL on kindergarten children's autonomous learning ability, with the goal of enriching the theoretical framework of PBL in early childhood education and offering actionable guidance for curriculum innovation.

Objectives

1) To compare kindergarten children's autonomous learning ability before and after participating in project-based learning.

2) To compare kindergarten children's autonomous learning ability with the criterion set at 70 percent.

Literature Review

Early childhood learning is a dynamic process where young children actively construct cognition, abilities and learning tendencies through engagement with the environment and social interactions instead of passively receiving knowledge, a process that abides by age-related developmental laws and requires external scaffolding support. As Piaget (1952) emphasized, this learning is stage-dependent, with children in the 0–2-year-old sensorimotor stage and 2–7-year-

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old preoperational stage building cognitive schemas via assimilation and accommodation through active exploration; Vygotsky (1978) highlighted that it is driven by social interaction, as children internalize cultural tools like language with the help of more capable individuals and make progress within their Zone of Proximal Development (ZPD) under scaffolded support. For the core of early childhood learning, Katz (1992) focused on the significance of learning quality including traits like curiosity and persistence, which are nurtured by postnatal educational environments rather than being innate; Overall, early childhood learning develops from concrete experiences to preliminary cognitive abilities under the combined influence of age-related cognitive stages, social interaction, learning quality and instinctive exploration, embodying the multidimensional integration of physical and mental processes that empowers children to actively construct knowledge and abilities.

PBL is a student-centered instructional approach that organizes learning around extended, authentic projects driven by open-ended "driving questions" (Larmer & Mergendoller, 2010; Thomas, 2000). For preschool children, PBL is adapted to their developmental level, emphasizing play-based exploration, hands-on practice, and collaborative inquiry (Piaget, 1952; Vygotsky, 1978), as young children's cognitive development relies heavily on concrete experiences and social interactions. Core characteristics include:

1) Authenticity: Projects are closely linked to children's daily lives to stimulate intrinsic motivation, which aligns with the self-determination theory emphasizing the role of task relevance in fostering intrinsic motivation (Deci & Ryan, 2000).

2) Child Agency: Children actively participate in project planning, task division, and problem-solving, with teachers acting as facilitators rather than directors. This aligns with Vygotsky's (1978) sociocultural theory, which highlights children's active construction of knowledge through social interaction and adult guidance.

3) Collaboration: Group work is structured to encourage communication, role division, and mutual support (Blumenfeld et al., 1991). Such collaborative learning experiences are also supported by Pellegrino and Hilton (2012), who argue that collaborative inquiry helps young children develop social competence and shared problem-solving skills.

4) Reflection and Iteration: Children reflect on the project process, adjust strategies, and optimize outcomes based on feedback (Hosnan, 2014). This reflective practice is rooted in Schön's (1983) theory of reflective thinking, which emphasizes the importance of continuous reflection for learning and improvement, even in early childhood settings.

Based on the theories of Blumenfeld et al. (1991), Larmer and Mergendoller (2010), and Thomas (2000), this study adapted a five-step PBL process tailored to 5–6-year-old children, integrating insights from preschool education specialists :Identify genuine and valuable questions:

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Teachers design open-ended driving questions based on children's interests and life experiences, a practice advocated by Krajcik and Blumenfeld (2006), who emphasize that driving questions should be meaningful and relevant to learners' lives to promote engagement. 1) Guided exploration planning for autonomy and collaboration: Children work in groups to decompose tasks, assign roles, and develop project plans, with teachers providing tool templates or questioning guidance. This teacher role is consistent with Palincsar's (1998) scaffolding theory, which suggests that appropriate adult support can enhance children's autonomous learning and collaborative abilities.2) Deep exploration and cross-dimensional integration: Children engage in iterative exploration and integrate knowledge across domains to solve problems. This cross-domain integration is supported by Fosnot and Dolk (2001), who argue that young children construct knowledge through holistic, interdisciplinary exploration rather than isolated skill practice.3) Output of achievements and multivariate evaluation: Children produce tangible outcomes and participate in multi-dimensional evaluation (peer review, teacher feedback, public display). This multi-faceted evaluation approach aligns with Gipps (1994), who emphasizes that evaluation in early childhood should be comprehensive, process-oriented, and involve children's active participation.4) Reflection iteration and benchmarking against reality: Children reflect on the project process, revise plans based on feedback, and connect outcomes to real-life scenarios. Boud et al. (1985) support this reflective iteration, noting that reflection helps young children link their experiences to new learning and apply knowledge in real contexts.

Existing research on PBL in early childhood education, though limited, has shown positive effects. For example, Farida and Rasyid (2019) found that PBL enhanced young children's social development and problem-solving skills. Maulidah and Abdillah (2023) reported that PBL improved children's creativity and collaborative abilities, consistent with Siew et al. (2017), who also found a significant positive correlation between PBL participation and preschoolers' creative thinking. However, these studies often lack rigorous experimental design or systematic assessment of autonomous learning ability. In contrast, PBL research in primary/secondary education has consistently demonstrated its effectiveness in enhancing autonomous learning (Thomas, 2000; Wenglinsky, 2000), suggesting potential applicability in preschool settings—though age-appropriate adaptation is critical (Copple & Bredekamp, 2009; Piaget, 1952). Kindergarten children's autonomous learning ability is a developmental process where children, driven by intrinsic interests and motivation, independently select content, adjust strategies and construct knowledge through exploration and interaction with the environment under adult guidance, achieving coordinated cognitive, emotional and behavioral development. Theoretically, Montessori (1967) held it is a natural instinct relying on children's absorbent mind in a prepared environment; Dewey (1916) stressed it involves knowledge construction through hands-on

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practice and experience reorganization; Liang (2024) noted its characteristics of personalized choice and operational exploration, while Piaget's theory highlighted alignment with preoperational stage thinking and Vygotsky's sociocultural theory emphasized scaffolding support. It consists of four dimensions: environment-material interaction, practice-experience construction, cognitive-emotional motivation and behavioral-decision regulation. Its value lies in laying lifelong learning foundations (Montessori, 1967), promoting cognitive and personality development (Dewey, 1916; Piaget, 1952), adapting to personalized needs (Liang, 2024) and optimizing the educational ecosystem (Yu, 2021).

Conceptual Framework

This study focuses on two core variables: project-based learning (PBL) and kindergarten children's autonomous learning ability. The independent variable, project-based learning, is conceptualized as an experiential, inquiry-driven instructional approach in which children actively engage in meaningful, real-world projects to construct knowledge. This aligns with Dewey's (1938) principle of learning by doing and is supported by foundational PBL scholarship emphasizing authentic tasks, sustained inquiry, and collaborative problem-solving (Blumenfeld et al., 1991; Thomas, 2000).

The dependent variable, kindergarten children's autonomous learning ability, refers to children's capacity to independently initiate, choose, plan, sustain, and adjust their learning behaviors based on intrinsic motivation. This concept is rooted in Montessori's (1967) emphasis on children's natural tendency toward independence, self-directed activity, and exploration within a prepared environment, as well as Dewey's view that autonomy develops through reflective thinking and active participation.

Grounded in these theoretical perspectives, the study posits that PBL provides optimal conditions for enhancing young children's autonomous learning by encouraging initiative-taking, decision-making, exploration, and self-regulated problem-solving.

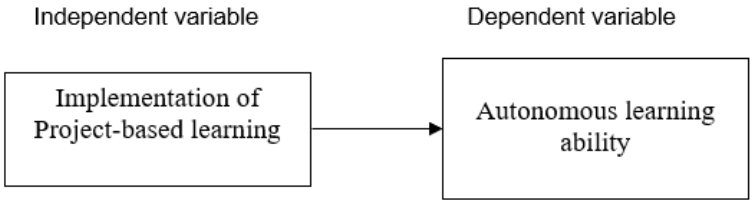


Figure 1 Conceptual Framework

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Methodology

1) Population and sample

1.1) The population of this study comprised of 80 kindergarten children from two senior classes at the Kindergarten of the Academy of Military Sciences.

1.2) The sample of this study comprised of 40 kindergarten children from one senior class at the Kindergarten of the Academy of Military Sciences. The sample was selected using the cluster random sampling method.

2) Experimental design

This study used one group pretest-posttest design shown in the below figure

O_1	X	O_2

O_1 was measurement of the kindergarten children's autonomous learning ability before an experiment

X was project-based learning

O_2 was measurement of the kindergarten children 's autonomous learning ability after an experiment

3) Research instruments

3.1) 6 Lesson plans covering themes such as "Building a 'Mini Community' with Blocks" and "Designing a 'Seed Growth Observation", totaling 12 teaching hours. The lesson plans was validated by experts and demonstrated a very high level of appropriateness, with an overall mean score of 4.60 (SD = 0.27).

3.2) Autonomous Learning Ability Observation Form (3-Level Rubric), It was developed based on a synthesis of relevant theories and expert validation. The instrument demonstrated good content validity, with IOC values ranging from 0.67 to 1.00, and reliability was confirmed through inter-rater consistency testing. The instrument evaluates four dimensions: (1) interaction with the environment and materials, (2) practice and experience construction, (3) cognitive and emotional motivation, and (4) behavioral and decision regulation.

4) Data Collection

The procedures of data collection were as follows:

4.1) The teacher provides project based learning orientation for kindergarten children before learning.

4.2) The sample was given the pretest by measuring autonomous learning ability with observation form.

4.3) The samples were taught by using project based learning.

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4.4) After finishing the instruction, the samples received the posttest by using the same instrument which was used in the pretest.

5) Data Analysis

In this study, data were analyzed by using the statistical program according to the research objectives

5.1) Compare autonomous learning ability before and after receiving project based learning by using t-test for dependent samples.

5.2) Compare autonomous learning ability after receiving project-based learning using a one-sample t-test.

Results

The findings based on the two research objectives were summarized in this paragraph.

1) The result of comparing kindergarten children's autonomous learning ability before and after participating in project-based learning.

Table 1 The result of comparing the mean scores of autonomous learning ability before and after project-based learning

Group	Full scores	n	Pre-test scores		Posttest scores		*t*	*p*
			M	*SD*	*M*	*SD*		
Experimental group	45	40	21.65	2.26	35.40	2.05	32.37**	.000

** $p < 0.01$

As shown in Table 1, the mean score of kindergarten children's autonomous learning ability after participating in project-based learning (M = 35.40, SD = 2.05) was higher than before participation (M = 21.65, SD = 2.26). The results indicated a statistically significant difference between the pre-test and post-test scores at the .01 level ($t_{39} = 32.37$, $p < .01$).

2) the results of comparing kindergarten children's autonomous learning ability against the 70 percent criterion

Table 2 The results of kindergarten children's autonomous learning ability compared with the 70 percent criterion

Group	n	Full score	criterion score	*M*	*SD*	*t*	*p*
Experimental group	40	45	31.5	35.4	2.05	12.04**	.000

** $p < 0.01$

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As shown in Table 2, the mean score of kindergarten children's autonomous learning ability in the experimental group was 35.40 (SD = 2.05), which was higher than the criterion score of 31.50 (70 percent). The results indicated that the mean score was significantly higher than the criterion at the .01 level (t_{39} = 12.04, p < .01).

Discussion

Project-based learning (PBL) can significantly improve kindergarten children's autonomous learning ability, and their post-intervention scores are significantly higher than the preset 70% proficiency criterion. The reasons for this positive effect are multi-dimensional, closely related to the characteristics of PBL itself, the developmental laws of young children, and the practical design of the research, specifically as follows:

1. After participating in PBL intervention, children's autonomous learning ability was improved significantly. The post-intervention mean score was 35.40, much higher than the pre-intervention mean score of 21.65, with a significant difference at the 0.01 level. This core improvement stems from PBL's precise alignment with young children's learning nature. As Piaget (1952) pointed out, 5–6-year-old children are in the pre-operational stage, relying on concrete image thinking and active exploration to construct knowledge. PBL abandons the passive knowledge transmission of traditional teaching, and through theme-based projects such as "Building a 'Mini Community' with Blocks" and "Designing a 'Seed Growth Observation'", it transforms abstract learning objectives into tangible, operable tasks. Children gain direct experience through hands-on practice, trial and error, and collaborative exploration, which fully conforms to Dewey's "learning by doing" concept. Meanwhile, the five-step instructional process of PBL—identifying genuine and valuable questions, guided exploration planning for autonomy and collaboration, deep exploration and cross-dimensional integration, output of achievements and multivariate evaluation, and reflection iteration and benchmarking against reality—gradually cultivates children's ability to independently initiate tasks, plan processes, and adjust strategies. Thomas (2000) emphasized that PBL's emphasis on autonomy and constructive investigation can effectively enhance students' initiative, which is fully verified in this study: children actively propose ideas during project implementation, independently resolve small conflicts in cooperation, and continuously optimize their exploration methods, all of which reflect the improvement of autonomous learning ability.

2. After the PBL intervention, children's autonomous learning ability scores significantly exceeded the 70% proficiency criterion (31.5 points), with a post-intervention mean score of 35.40, indicating that PBL can effectively help most children reach or exceed the expected developmental level. This result is closely related to the scientific design of PBL lesson plans and

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the multivariate support system. On the one hand, the six lesson plans designed in this study are closely integrated with children's daily life, covering community, nature, life management and other themes that children are familiar with and interested in. Such real-life connection stimulates children's intrinsic motivation—according to Blumenfeld et al. (1991), when learning content is linked to students' interests or practical needs, it can significantly enhance learning engagement. On the other hand, the expert-validated lesson plans (overall M=4.6, SD=0.27) ensure the appropriateness of teaching content and methods, avoiding excessive difficulty or triviality that may affect learning effects. Additionally, the multivariate evaluation mechanism in PBL (including peer evaluation, teacher feedback, and public display of achievements) not only provides comprehensive feedback for children's learning but also enhances their sense of achievement and self-efficacy. As Vygotsky's Sociocultural Theory suggests, scaffolded support from teachers and positive interactions with peers help children break through their zone of proximal development. In this study, teachers provide targeted guidance rather than direct answers, allowing children to independently complete problem-solving processes, which effectively consolidates their autonomous learning skills.

3. The long-term developmental value of PBL further explains its effectiveness in improving autonomous learning ability. Unlike traditional teaching that focuses on short-term knowledge mastery, PBL emphasizes the cultivation of cross-situational transferable abilities. During the project process, children not only master specific skills but also gradually form learning qualities such as curiosity, persistence, and collaborative awareness—qualities that Katz (1992) believed are the core of lifelong learning. For example, in the "Toy Sorting Problem" project, children not only learn classification methods but also develop the habit of independently solving practical problems; in the "Story Book for Little Animals" creation, they exercise creative thinking and rule-abiding awareness in collective cooperation. These qualities and habits are internalized into children's stable psychological traits, laying a solid foundation for their subsequent learning and development. Moreover, PBL's emphasis on reflection and iteration helps children develop metacognitive abilities—they learn to review their own learning processes, summarize experiences and lessons, and continuously improve their autonomous learning strategies, which is a key manifestation of the development of autonomous learning ability.

4. The positive effect of PBL also benefits from the synergy of home-school collaboration implied in the research design. The pre-class parent-guided observation and after-class extended tasks extend the PBL learning scene from the kindergarten to the family, forming a consistent educational atmosphere. As mentioned in the research significance, PBL helps parents recognize the value of "learning through play", reduces their anxiety about "elementary school-style education", and thus actively cooperates with kindergarten teaching. This home-school synergy

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provides continuous support for children's autonomous learning—they can apply the autonomous exploration methods learned in kindergarten to family life, further consolidating and improving their autonomous learning ability. Such synergy not only enhances the immediate effect of the intervention but also promotes the sustainable development of children's autonomous learning ability.

Recommendation

1) Recommendations for Practice

1.1) Promote PBL Application in Preschools: Popularize the validated PBL lesson plans and assessment tools, guiding frontline educators to master PBL design, implementation, and evaluation methods through training and workshops.

1.2) Optimize PBL Curriculum Design: Combine local cultural characteristics and children's developmental needs to adjust PBL themes and content, ensuring curriculum appropriateness and practicality.

1.3) Strengthen Home-School Collaboration: Communicate PBL concepts and practices to parents, guide them to support children's autonomous exploration at home, and form a joint educational force.

1.4) Improve PBL Support Conditions: Allocate resources to provide sufficient materials, time, and space for PBL activities, and establish a teacher support system to address implementation challenges.

2) Recommendations for Further Research

2.1) Expand Sample and Research Scope: Select children from different regions, kindergartens, and age groups to enhance result generalizability.

2.2) Conduct Longitudinal Follow-up Research: Track children's autonomous learning ability and long-term development after PBL intervention to explore its lasting impact.

2.3) Carry Out Comparative Research: Compare PBL with traditional teaching methods or other innovative approaches to clarify PBL's unique advantages.

2.4) Deepen Research on Influencing Factors: Explore how factors such as teacher competence, classroom environment, and children's individual differences affect PBL's effectiveness.

2.5) Integrate Digital Technology into PBL: Explore the application of digital tools such as educational apps and virtual reality in PBL to enrich teaching forms and enhance effectiveness.

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