

A Review of Research on the Application of Embodied Cognition Theory in Chinese Education

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Abstract: *The concept of embodied cognition offers a new perspective on altering education and instruction by highlighting that human cognition is produced through interaction between the body and the external world. This paper begins with a development history of embodied cognition, explains the relationship between embodied cognition and education, and then delves further into the implications of embodied cognition for schooling. The study then examines three aspects of embodied cognition theory: the development of a learning environment, the collision of teaching and learning concepts, and the direction of educational and teaching activities. This is done by gathering and organizing key literature on embodied cognition and education in the CNKI database. To explore an embodied education path with Chinese characteristics, it is finally suggested that the educational implications of embodied cognition be integrated. This includes developing the concept of unity of mind and body, creating contextualized embodied learning environments, and designing experiential school-based curricula.*

Keywords: Embodied Cognition Theory; Educational Implications of Embodied Cognition; A Review of Applied Research.

1. Introduction

Embodied Cognition Theory is one of the more cutting-edge topics in the field of cognitive science research, which emphasizes the involvement of the body and has led to a rethinking of the relationship between cognition, the body, and the environment. In the past decade, many researchers from China have also focused on the advantages of this theory in integrating education and believe that it can provide new ideas for solving the crises of the implementation of traditional Chinese education, such as "detachment from the body," formality, and alienation in the school.

2. Exploration of the Development History and Connotation of Embodied Cognition Theory

2.1 Origins and Development of the Theory of Embodied Cognition

The theory of embodied cognition can be traced back to the ancient Greek period when Socrates first proposed the separate existence of the body and the soul, categorized under the dichotomy of mind and body^[1]. On this basis, Plato further pointed out the need to promote rationality and reject the sensory desires connected with the body, believing that the body and soul are separate. Descartes suggested that "we experience things only through the rational faculties of the mind, not through imagination, nor the senses."^[2] Cognition is not dependent on the physical body, bringing the mind-body dichotomy to its peak. On the other hand, the theory of embodied cognition is entirely antithetical to the mind-body dichotomy. The view of embodied cognition has its roots in phenomenology and biology. In 1965, the French phenomenological philosopher Merleau-Ponty proposed that human beings interact with the outside world with the help of their bodies and that bodily experience should be emphasized. This statement laid the theoretical foundation for the development of embodied cognition^[3]. As a result, in the 1980s, this view of disembodied cognition, divorced from the body and the environment and detached from real life, was questioned and challenged in a whirlwind of ongoing debate,

and the bias of traditional cognitive science in understanding epistemic activity pushed cognitive science to seek a new way forward in research.

The concept of embodied cognition originates from the dilemma of traditional cognitive psychology. Nietzsche proposed that the body is the subject of cognition in 1885, which is the forerunner of the theory of embodied cognition, pointing out that the body is memorable and that the soul is vain and meaningless. He attacked the feudal superstitious thought that the soul is above all with the help of religious-related remarks and emphasized the body's subject position in the cognitive system, which confirms the fundamental idea of embodied cognition theory and emphasizes the importance of the human body. After that, Wei Du expressed his concept of embodied cognition in 1896, and his idea of "learning by doing" reflected the influence of embodied cognition theory in his educational thought. The German philosopher Heidegger asserted that human beings are embedded in the world and gain knowledge of the world through the interaction between their bodies and objects. This laid the ideological foundation for the theory of embodied cognition that integrates cognition, body, and environment^[4]. The research of these scholars laid a good foundation for the formation of the theory of embodied cognition. At the end of the twentieth century, Piaget's theory of emergent cognition and Vygotsky's theory of internalization both emphasized the role of the internalization of bodily activities on the process of thinking and cognition. They refuted the view of the dichotomy between mind and body^[5]. Traditional cognitive psychology was caught in a developmental dilemma under internal and external criticisms, and embodied cognition gradually became the new orientation of modern cognitive psychology. After that, Andy Clark summarized the complete theory of embodied cognition, attempted to abandon the traditional cognitivist concept of mind-body dichotomy completely, and used physical research means to study the theory of embodied cognition, and this method has become the most complete and effective method so far.

2.2 The Meaning of Embodied Cognition

The core connotation of embodied cognition is that the body plays a crucial role in the cognitive process and that cognition is shaped through the experience of the body and the way it moves, meaning that "the cognitive process is rooted in the body and is shaped by the body's interactions with the world in the course of the individual's perceptions and actions."^[6]

Some scholars believe embodied cognition has three characteristics: first, cognition is body-involved. Comprehension cannot be detached from the concrete body; understanding relies on the physicality of the organism, and the content of cognition, the process of cognition, and even the way of awareness are determined by the body's movement, experience, or muscular state. Second, understanding is experiential. People's view of the world from the body and the external environment is caused by the interaction of things in the physical state of change, that is, once a person and the outside world of a particular item after mutual contact with the role of the body experience will make it at the same time or after that a period to a fixed cognitive way to recognize and understand other things. Thirdly, cognition is contextual. Context is an indispensable condition for ensuring cognition. From the experiential nature of cognition, it can be seen that the content of cognition, the process of cognition, and the way of awareness are closely related to the body, which is the body in the environment, so cognition should likewise be extended to the environment where the cognizer is located. When cognition occurs in real-time interaction between the body and the environment, in a specific context, the physical and the social environment in which the body is situated can profoundly affect the cognitive process^[7].

It can be seen that the body plays a vital role in the development of human cognition. Embodied cognition emphasizes that the body, cognition, and environment are an inseparable whole and covariate in interaction.

3. The Link between Embodied Cognition Theory and Education

According to the connotations of embodied cognition, it is possible to see its educational implications and simultaneously, reveal the shortcomings of traditional cognition. Many things could still be improved in the conventional learning process. The theory of dichotomy of body and mind agrees that curriculum is the entity of school education, and the mechanical split and separation between curriculum and teaching map out the embodiment of the theory of dichotomy of body and mind in school education. For example, in the primary education stage, schools do not pay enough attention to labor education, so students are outside of labor education; labor education does not enter the students' cognition, not to mention the students' physical practice and the phenomenon of emphasizing intelligence over labor is widespread^[8]. In teaching other courses, schools must also pay more attention to interpreting knowledge and theory. The teaching effect is reflected in the memorization, expression, repetition, and other "above the neck," ignoring the analysis of practical cases and related practical activities, resulting in the education staying at the cognitive level. The emergence of embodied cognition undoubtedly breaks the traditional concept of indoctrination education. Therefore, we should re-examine the relationship between embodied

cognition and education and accelerate the transformation of education mode. The connection between embodied cognition theory and education is mainly reflected in the following aspects.

3.1 Experiential Education

When the experiential nature of embodied cognition is extended to the category of education, "experience" should be an indispensable way to acquire knowledge, that is, in the process of educating and guiding the students, the construction of the knowledge system of the teacher should not rely on the a priori concepts and knowledge that are independent of the subject. Still, it should depend on the subject's perception, experience, and the resultant interpretation of the external things. Interpretation^[9]. China's current education model shortens or even ignores the process of perception and experience of knowledge when imparting knowledge. From the embodied cognition perspective, input-type knowledge transmission violates the fundamental laws of human cognition. It is challenging to help students internalize what they have learned, and they can't achieve an in-depth comprehension and grasp of knowledge. Therefore, under the guidance of the theory of embodied cognition, it will inevitably lead to changes in education and teaching, that is, to carry out experiential education that integrates body and mind.

3.2 Contextual Education

When the contextualization of embodied cognition is extended to education, context is one of the most important factors influencing the effectiveness of teaching and students' learning process^[10]. Whether teachers can trigger students' embodied effect and whether students can produce embodied experience in the learning process depends on the vividness and realism of the teaching context, and the more vivid and realistic the context is, the more it can trigger the individual's physical experience. Especially in learning abstract concepts or students' lack of existing perceptual experience, the re-creation and rendering of the context is paramount. Therefore, the setting of the teaching context creates the conditions for individual embodied experience and makes the embodied effect possible.

3.3 Generative Education

The teaching process in embodied cognition theory is the integration and utilization of cognition, body, and environment, and there is no absolute subject-object relationship between teachers and students. Still, students and teachers become co-participants in teaching and learning activities under the mediation of the environment^[11]. Teachers in the atmosphere have their own particular life experiences and information systems. They are part of the environment, while students in the background are in constant dialogue with the environment and the teachers who make up the environment based on their personal life histories and past experiences under the sway of their physical states. In this process, two different information systems, the teacher and the student, merge and influence each other, gradually generating, emerging, or transforming new knowledge^[12]. Therefore, in the teaching process of teacher-student

interaction under the embodiment theory, the teacher's attitude toward the students, the interaction between the teacher and the students, and the continuous deepening of the students' experience become essential factors influencing the students' learning. At the same time, students' attitudes toward teachers and interactions with teachers also affect teachers' cognitive development. As a result, new experiences, meanings, and knowledge are continuously generated. However, the teacher still plays a leading role in the learning process, in which the teacher can create the conditions for the student's experience by guiding or evoking the students' experience with words, i.e., triggering the students' embodied effect. As a result, the entire teaching process has changed from a one-way flow of knowledge to a two-way interactive process, where the experience of both teachers and students has far exceeded the limitations of individual physical and mental experience and ultimately not only achieves the students' generative learning but also promotes the teachers' learning growth.

Under the guidance of the theory of embodied cognition, new dimensions of education and teaching are extended. However, they are still considered from the starting point of mutual promotion among body, context, and cognition. In the teaching process, our body is in the environment and interacts with the environment. Through the penetrating experience of the body in the background, students' bodies and minds

collide with the atmosphere to promote the integration of their bodies and senses for healthy development. Embodied cognition is rapidly being explored and applied in education with this pedagogical vision.

4. Research Progress of Embodied Cognition Theory in the Field of Education in China

Using a combination of two keyword lists as subject terms, this study searched the CNKI database for articles on "embodied cognition theory" ("embodied cognition theory" or "embodied cognition") and "education" ("teaching" or "learning"), ultimately selecting a total of 278 articles in CSSCI, CSCD, and core journals. ") and "education" ("teaching" or "learning"), and finally selected CSSCI, CSCD, and core journals, totaling 278 articles. According to the search results, it was found that the theory of embodied cognition has attracted the attention of many Chinese scholars since 2013, and the research trend has become more evident, as shown in Figure 1.

Under the guidance of the theory of embodied cognition, many researchers have proposed the concept of embodied learning and introduced illustrated design based on learners' embodied characteristics. Although embodied cognition has formed a small hotspot in education, its research topics are scattered and not in-depth, as shown in Figure 2.

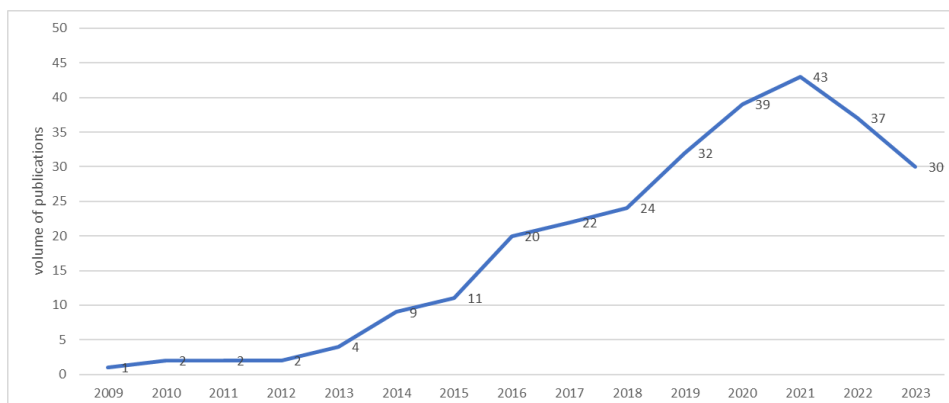


Figure 1: Trend of papers published on the subject of "embodied cognition theory" and "education"

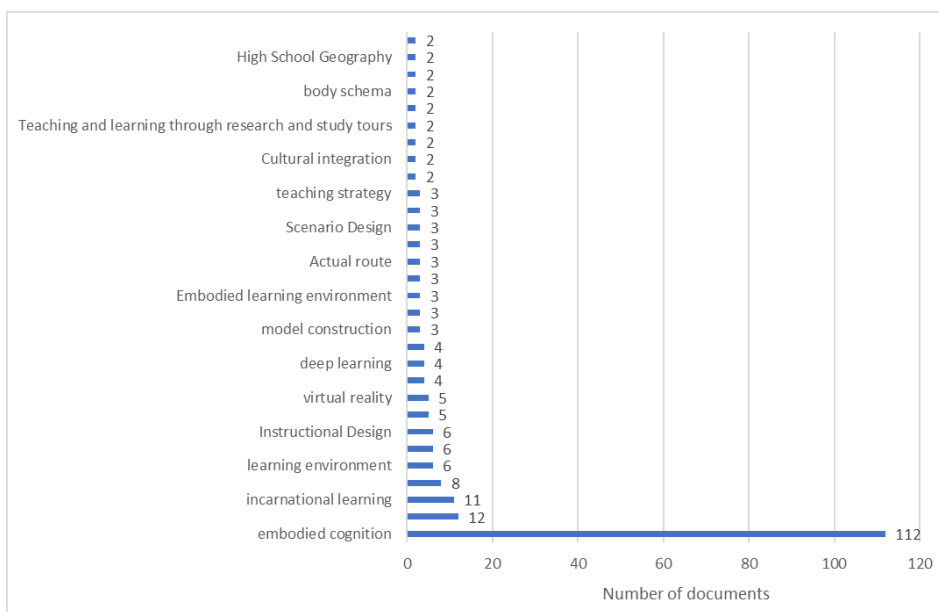


Figure 2: Thematic distribution of papers with "embodied cognition theory" and "education" as subject terms

To summarize, this study attributes the research themes to three aspects: the creation of the learning environment, the collision of teaching and learning concepts, and the guidance of educational and teaching activities, as shown in Figure 3.

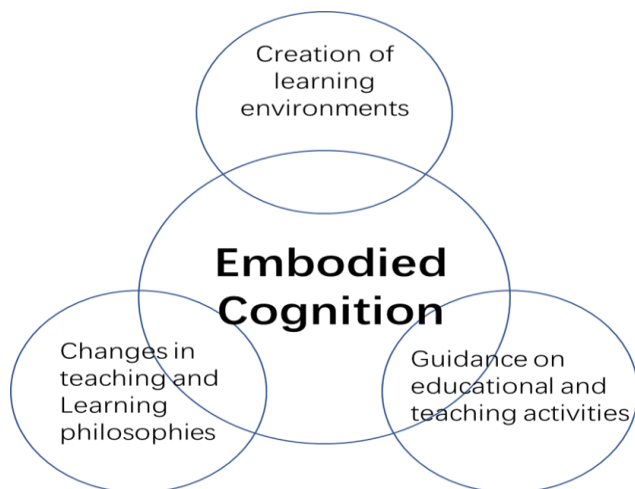


Figure 3: Relationship between embodied cognition and learning environment, teaching and learning concepts, and educational and teaching activities

4.1 The Creation of Embodied Cognitive Learning Environments

The embodied cognitive learning environment is a kind of embedded learning environment in which the mind is embedded in the brain, the brain is embedded in the body, and the body is embedded in the background, which is based on the theory of embodied cognition under the integration of body and mind and the integration of subject and object^[13]. Creating embodied cognition learning environments has already had relevant and mature research in China. Some scholars have summarized the typical international studies on embodied cognitive learning environments and classified embodied cognitive learning environments into three categories: sensory enhancement, proportional postural movement, and body participation in activity^[14]. These studies on creating embodied cognitive learning environments can be traced back to the degree of embodiment of the learning environment, i.e., the interaction between the learner's body and the technology. Price et al. have also categorized the degree of the image into off-body interaction, near-body interaction, and on-body interaction^[15]. Off-body interaction emphasizes the interaction with technology that is prevalent in the living world, in which body movement does not play a dominant role; near-body exchange refers to the human body as an intermediary to interact with technology, such as gestures and other body movements, individual position sensing, etc.; on-body discussion refers to the augmentation and invocation of the body's sensory perception by wearable and implantable devices.

4.1.1 The Construction of Learning Environments from the Perspective of Embodied Cognition

In this study, the embodied cognitive learning environments were reorganized and classified into off-body interactive learning environments, near-body interactive learning environments, and on-body interactive learning environments based on the division of the degree of embodiment.

Meanwhile, 278 pieces of literature searched were eliminated and organized, and finally, 26 articles of empirical research were selected and classified into these three categories, as shown in Figure 4.

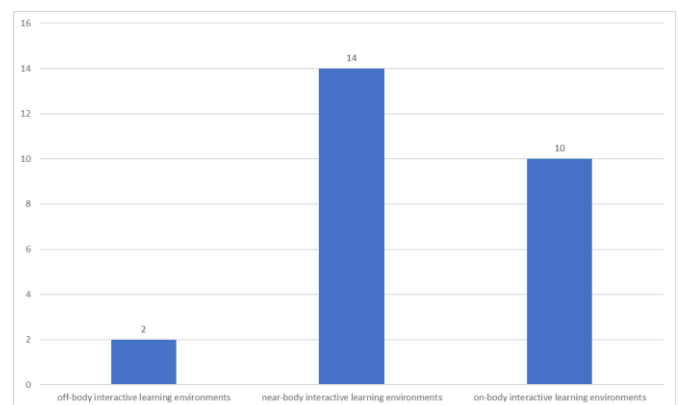


Figure 4: Construction of learning environment under the perspective of embodied cognition

In the context of disembodied learning environments, this study takes as an example the study of Haifeng Li et al., who designed and developed an online virtual learning community for elementary school English based on the guidance of embodied cognition theory^[16]. The results found that the embodied cognition learning environment promotes learners' learning more than the web-based version of the learning environment. Haichi Ye et al. used 3D gesture computing in a close interactive learning environment for four teaching processes: reading, foreign language, science, and skill training. The study showed that the gestures and even physical behaviors of learners supported by 3D gesture computing can effectively promote students' understanding of complex knowledge and stimulate their interest in learning^[17]. In the in-person interactive learning environment, the helmet-type VR device is China's most used embodied technology. Yiling Hu et al. analyzed the difference in learning experience and learning effectiveness between immersive VR environment and 2D desktop simulation software environment from the theory of embodied cognition. They found that compared with 2D simulation software, the VR experimental environment promoted the transfer of behavioral skills and problem-solving in real-world situations and significantly enhanced learners' self-efficacy and sense of presence experience^[18]. It can be seen that the learning environment brings more to the student's learning experience as the degree of embodiment increases.

The above studies discussed the construction of an embodied learning environment. Still, some reflections on the structure of the embodied learning environment only addressed the interaction between students and the environment and emphasized the importance of the construction of the embodied learning environment but did not recognize that learning is a complex process, which not only requires the provision of the embodied learning environment, the interaction between the learner and the environment, but also requires the learner's cognition and knowledge of holistic learning, and ignores many of the influencing factors of the learner himself, as well as the influence of the objective aspects of the teacher, the school, the society and so on.

4.1.2 Exploration of Different Perspectives on the Construction of Learning Environments from an Embodied Cognitive Perspective

Constructing an embodied learning environment involves the interactions among educators, learners, and educational activities and the interactions between the three and the surrounding environment. Therefore, many scholars explore the construction of embodied learning environments from different theoretical perspectives and present their concepts. It is noteworthy that Zhihe Li et al. pointed out that the embodied cognitive learning environment is an organic system consisting of four parts: physical environment, sociocultural environment, resource-supportive environment, and emotional-psychological environment, and analyzed that the atmosphere contains elements such as the learner and the physical facilities, the teaching materials, the embodied technology, and the teaching context and that the components interact and develop in a coupled manner^[19]. Xudong Zheng and Meixian Wang discussed the construction of embodied cognitive learning environments from the perspectives of educational technology^[20], static presuppositions to the dynamic generation of the new system view^[21], ecological psychology^[22], and dynamical systems theory^[23]. Wenxiang Fan and Ruibin Zhao explored the knowledge, learning, and teaching views of embodied cognition to provide some references for embodied teaching^[24].

4.2 Changes in Teaching and Learning Concepts

The conceptions of education and teaching founded on the dualism of body and mind have been called into question by embodied cognition. After examining the educational implications of embodied cognition, many academics have concluded that education is now firmly tied to the body below the "neck" and no longer only above it. In addition to offering educators helpful teaching techniques, embodied cognition also represents a form of conceptual breakthrough in education. When considering the transition from disembodiment to embodied cognition, Guanjun Qiu notes that embodied cognition science has caused a shift in the way teaching theories are thought of today. With an emphasis on knowledge and experience acquisition during the learning process, this shift gives greater attention to the contextualization of teaching, generativity of teaching, dynamics of teaching, and embodiment of teaching and research methodologies^[25]. According to Xudong Zheng and Meixian Wang, embodied cognition is the psychological basis of an embodied learning culture. The perspective of embodied technology highlights the reciprocal construction between the learner and the learning environment and between the learning culture and the learning environment. It advocates for the embodiment of curriculum and teaching to achieve the embodiment of learning^[26]. Ming Yin and Dianzhi Liu thoroughly analyzed embodied cognition and its educational implications. They looked at the meaning, traits, and types of embodied cognition and offered new perspectives on teaching. They concluded that contextualized teaching is a valuable teaching strategy for enhancing students' physical and mental experiences, removing negative physical constraints on teachers and students, and moving away from the traditional teaching of pure brain cognition to the active, experiential learning of physical and mental engagement. Finally, they

reached a path for generative learning through teacher-student interaction's physical and psychological integration. And the detrimental embodied consequences of physical limitations on educators and learners^[27]. In addition, the perspective of embodied cognition offers generative, immersive, and interactive assessment options for assessing instruction and learning.

4.3 Guidance on Educational and Teaching Activities

Several researchers have proposed an all-encompassing inquiry for the design process of instructional activities based on the perspective of embodied cognition. This inquiry covers all stages of the process, from conceptualization to framing to design to experimentation, and it offers learners support and guidance to better engage in embodied learning activities.

4.3.1 Design of teaching and learning activities

Li Shao investigates the framework of learning activity design under embodied cognition, which enhances the theoretical perspective of instructional design and offers helpful resources for educators to carry out the design of embodied learning activities^[28]. The fundamental principles of embodied instructional design were put forth by Jialina et al. These include analyzing the purpose of embodied teaching, examining learner characteristics, examining the embodied qualities of learning content, establishing an embodied teaching environment, planning embodied teaching activities, and conducting formative evaluation^[29]. By integrating virtual reality technology, Yanjun Yang and Jiahui Zhang further investigated an embodied learning activity design framework for immersive virtual-reality fusion environments. They thoroughly examined a learning activity design based on this framework. The findings demonstrate how this approach can enhance learners' fundamental literacy while providing more significant support for developing and implementing embodied learning activities in immersive reality-convergent environments^[30].

Furthermore, some researchers have discovered that young toddlers primarily use their senses to recognize the world through image-based thinking, consistent with the embodied cognition view's assertions. Zheng Xiaomei presented the concepts of activity design—subjectivity, bodily participation, contextualization, and the activity principle—after analyzing the relevance of embodied cognition theory in creating kindergarten storytelling instructional activities^[31]. This collection of scholarly research and design offers helpful resources for educators and learners in embodied learning, which is extremely important.

4.3.2 Implementation of teaching activities

In teaching and learning activities, embodied cognition incorporates a range of disciplines. Scholars have progressively investigated integrating embodied cognition with different domains and elaborated on the significance of including the theory in these activities. Additionally, as illustrated in Figure 5, our investigation searched 26 empirical research publications. The teaching of languages (English, Chinese, sign language, etc.) and engineering (information technology, programming, engineering courses, etc.) has been

the most common application of the theory of embodied cognition. Other application areas include geography, reading, and experimental manipulation (chemistry, physics, etc.), all part of teaching activities.

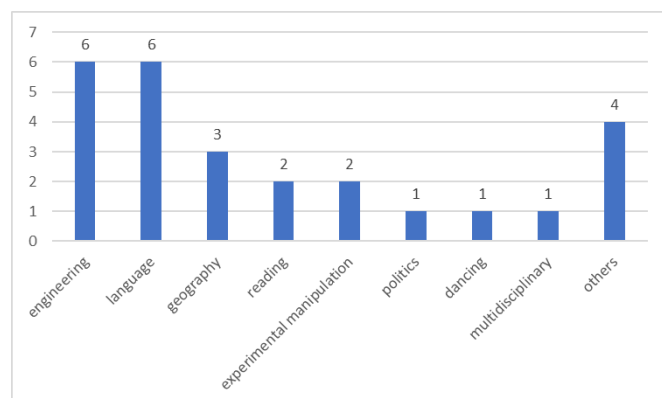


Figure 5: A statistical chart illustrating the use of embodied cognition in learning activities across multiple fields

Integrating educational technology to create a conducive learning environment is the primary way embodied cognition is expressed in instructional activity approaches. To teach graphic subjects, Junyang Li et al., for instance, strengthened the integration of embodied cognition and educational technology, made use of the theory of embodied cognition, and proposed a model of a VR contextual learning system that stimulates the learners' perceptual organs to improve the level of knowledge comprehension in the immersive experience^[32]. In the meantime, some scholars concentrate on how teaching activities are implemented, creating and designing educational software according to the theory of embodied cognition. For instance, Li Haifeng and Wang Wei created the "Sanitation Fighter" educational game for English word learning in the fourth grade of elementary school, which was implemented in the classroom and received positive feedback from teachers and students. They also built the EGEC educational game development framework based on embodied cognition theory^[33].

5. Conclusions and Outlook

5.1 Educational Implications of Integrating Embodied Cognition

5.1.1 Establishment of the concept of education for the unity of mind and body

"A student's body is the subject of their cognitive and mental development. The development of cognition depends on the subject's diverse experiences, which come from a living, breathing organism with a range of sensory and motor capacities^[34]. Students generally experience rapid physical development at all learning stages. In contrast to other intellectual education courses, labor education, physical education, science education, and other methods place greater emphasis on the practical application of the curriculum and the student's physical participation and development. Therefore, the educational concept of the integration of mind and body should be implemented to guide students' entire development to focus on kids' physical reparation in the classroom. Allow the educational concept of the unity of mind and body to realize its guiding role fully. Then, translate this

concept into a set of concrete, workable teaching objectives to help students attain the co-culture of mind and body and provide them with a path forward. Allow the students' bodies to be free in the designed learning environment so they can take charge of their bodies, explore, engage, experience, and perceive the domain from the inside out, give their bodies full rein to be autonomous and positive, actively engage in the learning process, and ultimately develop rich learning cognition.

5.1.2 Creating contextualized and embodied learning environments

The relationship and interplay between the body and the environment, rather than the teacher's formal lectures, generates students' learning cognition in the classroom. In primary and secondary education, students' thinking, memory, and other developmental stages are still immature, particularly in the lower grades. To help students learn more contextually and through immersive experiences, teachers should establish a range of settings inside and outside the classroom. Additionally, the creation of a contextual educational environment can be achieved in two ways: first, by creating an environment that is difficult for learners to touch through the use of virtual reality and other embodied technology, which allows them to understand the material in a variety of ways and allows them to practice the material and build the learning application in greater detail^[35]. The second step involves using gamification components to create a context-rich setting where instructional activities may be implemented, and a range of autonomous experience projects can be completed. To encourage the harmonious and cohesive development of the student's body and mind, role-playing exercises, such as those found in the labor education curriculum, are used to help students experience the substance and value of the work of various workers by having them assume the roles of doctors, police officers, cooks, and so forth.

5.1.3 Designing experiential school-based education programs

Wei Du's "learning by doing" theory strongly emphasizes pupils gaining firsthand experience and learning by doing. Students' direct and indirect experiences can be combined through the design of experiential school-based education programs, which aim to update concepts at the theoretical level while also reflecting the value of the body in particular practical courses^[36]. For disciplinary penetration, we may, for instance, hone the integration theme from each discipline. The labor education curriculum can be used as a starting point to refine the theme for discipline integration, even though most of the current curriculum is subdisciplinary. Each discipline has its distinctiveness. Students can engage in hands-on breeding and pruning in art and science classes, for instance, improving their aesthetic appeal and literacy while allowing them to experience labor and pleasure and fostering the integration of their direct and indirect experiences.

5.2 Exploring an Embodied Education Path with Chinese Characteristics

The field of embodied cognition was first studied outside of China, and it has only recently become popular there. In the meantime, Western philosophical and psychological studies continue to serve as the foundation for most Chinese research in this area. On the other hand, embodied cognition has roots in ancient China. Confucianism, for instance, the proverb "Do not do unto others as you would have them do unto you," Su Shi's "I know not the true face of Mount Lushan, only that I am here in the mountain," the reference to "Mencius' mother's three removals," etc. However, the current state of domestic research in China mostly centers on the history of embodied cognition theory and the discussion of the mind-body relationship. Most studies consider how to incorporate embodied cognition theory into curriculum design; they need to implement it. The lack of local research on embodied cognition has led to the weakness of empirical and applied studies in China. As a result, Chinese researchers should also focus on the features of teaching in interdisciplinary fields, identify an embodied education pathway that works for our national context and incorporates the best aspects of traditional Chinese culture, and present an embodied education paradigm that is localized as soon as feasible.

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