Research on Maker Education under the Theory of "Embodied Cognition"

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Abstract: Currently, there is a lack of teaching subjectivity in maker education, and there is also a problem of insufficient emotional resonance in practical teaching. However, through embodied practical operations, maker education courses can organically integrate students' emotions, attitudes, and wills, and achieve a transformation from "disembodied cognition" to embodied cognition. In this process, students can integrate the value concepts contained in maker education into their self-constructed "meaningful world". Embodied maker education teaching can adopt diverse designs, such as cooperative learning, teacher-student interaction, and situational setting, which have embodied characteristics. Through these methods, a path to improve the quality and efficiency of maker education can be constructed, and its focus on educating students can be returned to. The essence of embodied maker education is to cultivate students' innovation and creativity while promoting the maker spirit, allowing students to feel the value concept of "people-oriented" in practice and become lifelong learners with pursuits and values.

1. Introduction

Talent is an important indicator of a country's overall national strength. The new education model should be guided by the cultivation of high-quality talents. Maker education has become an important way of nurturing talents, as it follows the concept of "open innovation" and "exploratory experience", and takes "creating while learning" as the main learning method [1]. In 2018, the Ministry of Education issued the "Key Points of Education Informatization and Network Security Work in 2018", which explicitly stated that we should "deeply promote the application of information technology in teaching, explore the application of modern information technology in new teaching organization models, and explore the application of information technology in education and teaching new models such as maker spaces, interdisciplinary learning (STEAM education), and maker education." In 2019, the Central Committee of the Communist Party of China and the State Council issued "China's Education Modernization 2035", which proposed to "promote innovation and entrepreneurship education reform and cultivate students' innovative spirit and practical ability". This means that education no longer only focuses on the transmission of knowledge, but also pays more attention to cultivating students' innovative thinking and practical abilities [2].

In maker education, teacher guidance is crucial. Teachers should not only impart knowledge and skills but also guide students in exploration and design, cultivating their maker spirit and culture. At the same time, teachers need to provide suitable learning environments and tasks based on students' interests, levels, and needs, to stimulate their learning enthusiasm and innovative potential. However, in practice, teachers are often deeply influenced by the objective epistemology of subject-object separation and mind-body separation, leading to the teaching of knowledge independent of context and operation, and neglecting the importance of practice and action in maker education [3]. On the other hand, some teachers in maker education practice overemphasize practical operations, while neglecting students' learning and understanding of knowledge, resulting in students merely doing

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things in maker education without in-depth learning and thinking. Therefore, in maker education, teachers should balance knowledge and practice, while encouraging students to apply what they have learned to practice, to achieve a state of unity of knowledge and action [4].

The theory of embodied cognition is an innovative cognitive theory that emphasizes the close connection and coexistence between bodily processes and mental processes [5]. This theory provides educators with a new way of thinking, which incorporates bodily sensations and contextual interactions into instructional design. Physiological experiences "activate" psychological feelings, and vice versa, enabling educators to design diverse forms of instruction, such as cooperative learning, teacher-student interactions, and contextual settings, based on students' bodily sensations. This, in turn, fosters students' innovative awareness and practical ability in maker education [6]. Therefore, the theory of embodied cognition not only provides a new teaching method, but also offers profound philosophical guidance for educational transformation, allowing learners to better understand the inherent connections between the body, mind, and environment, making education more enriching and meaningful.

2. The embodied cognitive significance of maker education

The Marxist theory believes that human beings not only exist in the objective reality world but also create a world of meaning to reflect on the essence and value of existence. Maker education, including knowledge and skills teaching and practical operations, is influenced by the values and goals of ideology in terms of material sources, educational generation, basic practice, and theoretical dissemination in the curriculum design [7]. By combining "making to educate" with the fundamental task of cultivating morality and character, the Maker education curriculum has inherent relationships and internal order consistency, which ultimately contributes to the generation and value recognition of the human meaning world, becoming an inherent mechanism for fulfilling the educational value. As the Maker education curriculum has both theoretical and practical aspects, cognitive laws should be followed during the education process, focusing on strengthening ontological perception and constructing a self-meaning world based on it.

As a highly practical approach to education, the teaching of maker education should be based on practical needs, because without the support of the practice, the theory easily deviates from reality. However, there is currently a teaching form of "disembodied cognition" in maker education courses, which has led to a clear problem of lack of subjectivity for learners. At the same time, maker education practice courses, which have long been influenced by pragmatic philosophy, focus on practical operations and exhibit a utilitarian mentality, which has created an implicit problem of emotional dissonance. Maker education is not only about knowledge as a form of understanding, but more importantly, it is about internalizing the skills that individuals acquire, integrating emotions, attitudes, and wills through practice, and realizing the transformation from "disembodied cognition" to "embodied cognition". In this process, the value of maker education will be melted into conscious products constructed by the self.

2.1. The Connotative Characteristics of "Personal Cognition"

In cognitive science, mind-body dualism emphasizes the role of symbols and representations, regarding cognition as a process of information processing. However, this dualism neglects the actual function of the body and experience in cognition, treating the body merely as a biological part. The emergence of embodied cognition theory makes us aware that the body should not be viewed as a separate part of the cognitive subject, but should be unified with the mind, becoming an essential part of the cognitive process. Embodied cognition theory holds that the brain is not the sole source of cognition, but that the body and brain interact with each other in specific contexts, forming a unified cognitive whole of body, mind, and environment [8]. More and more psychologists are beginning to pay attention to the role of the body in cognitive formation, realizing that the traditional psychological meaning of the "body" is not only a physiological attribute but also a shaper of the mind.

According to the theory of "embodied cognition," cognition is not just a simple processing of symbols and representations, but a complex process of processing and re-computing bodily

experiences[9]. Bodily sensations are an important source of cognition, forming diverse cognitive contents through various types of bodily experiences such as sight, hearing, and touch. Under this theory, the role of embodied experiences in cognition cannot be ignored. For example, semantic processing in situational communication is often more effective than simply reading and learning, as the situation provides multiple bodily experiences such as sight and sound. Maurice Merleau-Ponty, the founder of phenomenology, pointed out that the experiences acquired by the body constitute the content of consciousness, and from a phenomenological perspective, explained the theory of embodied cognition, which regards the conscious experience of the mind as body experience. Maker education itself is a practical-oriented approach to education, and in the educational process, attention should be paid to integrating students' bodily sensations and cognition. Only through practice can students truly experience and feel the essence and connotation of knowledge, forming truly "experiential learning."[10] At the same time, this "embodied cognition" approach to education can also better cultivate students' creativity and innovation, allowing them to continuously try and explore in practice. As Merleau-Ponty said, bodily sensations are an important content of consciousness, and maker education provides students with a perfect platform to constantly expand their bodily sensations and cognitive abilities in practice, ultimately becoming independent thinkers and innovators. Therefore, in maker education, educators should focus on cultivating students' bodily sensations and cognition, allowing them to constantly explore and discover their potential, becoming talented individuals with unique thinking and creativity.[11]

2.2. The Significance of Maker Education under "Personal Cognition"

According to the theory of "embodied cognition," traditional maker education lacks interaction with the environment, making it difficult to arouse emotional resonance and identification. However, maker education under the theory of embodied cognition can use the advantage of practice to enhance environmental interaction, thereby increasing students' positive psychological experience and sense of identification. Through innovative teaching methods and rich environmental resources, maker education stimulates students' creativity and imagination, allowing them to fully unleash their talents and abilities. This type of education allows students to enjoy learning and gain a sense of achievement, thereby satisfying them emotionally. Through practical projects such as team collaboration and community activities, maker education allows students to interact more deeply with the environment, increasing their connection and sense of identification with it. For example, students participate in community activities, gain a deeper understanding of the local environment, culture, and social issues, and experience local lifestyles and values. Finally, by designing projects with social significance, maker education allows students to feel their value and sense of mission in practice, integrating their bodies, minds, and environment, thereby achieving the educational effect of internalization and externalization. Maker education, with the power of practice, allows students to feel the meaning and value of life in interaction and then reflect on the connection between themselves and the world in action, achieving true growth and development.

The "perceptual symbol system" proposed by Barsalou represents an important aspect of embodied cognition theory, which emphasizes the significance of bodily experiences in cognition. Such bodily experiences are formed through perception, emotion, behavior, and other means, and are subsequently reactivated and processed in simulation. This simulation process provides important theoretical support for understanding the educational mechanism of maker education under the framework of embodied cognition theory. Under the guidance of the moderate approach of embodied cognition theory, the design and construction of a maker education curriculum can be connected with the process of shaping bodily experiences, thereby enhancing the influence of bodily experiences on the mind. In such an educational environment, students can obtain relevant bodily experiences of maker education curriculum through self-experience, object experience, and experience of others as intentional agents. These experiences will be processed by the brain into a multi-channel feature cognitive representation, leading to a profound understanding and application of the learned knowledge. Therefore, embodied cognition theory provides an upgraded educational model for maker education, which promotes learning and development through bodily experiences. If maker education

places more emphasis on self-experience, various creative practical activities can be utilized to enhance students' bodily experiences. For example, students can participate in various practical creative projects such as design, programming, and manufacturing, thus gaining rich bodily experiences through practice. In addition, students can also gain bodily experiences through collective experiences such as teamwork and role-playing. In this process, students are not merely passive recipients of knowledge, but actively construct their cognitive structures through bodily experiences, and apply the learned knowledge to practical life. In this way, students can gain a deeper understanding of the learned knowledge, while also cultivating their creative thinking and problem-solving abilities. Therefore, maker education under embodied cognition theory helps to address the issues of the lack of student subjectivity and emotional resonance in education.

3. The Practical Path of Maker Education under the Theory of "Personal Cognition"

The value of maker education lies in students' identification with and transformation into the action of the taught content. However, traditional maker education courses suffer from certain problems, such as the passive acquisition of material information and lack of embodied experience in the learning environment. Due to differences in students' cognitive structures, this passive learning often leads to a sense of detachment from the course content, making it difficult to achieve in-depth thinking, emotional resonance, and action transformation. Therefore, maker education should focus on students' subjectivity, fully utilize the teaching environment, enable students to better grasp knowledge and skills, internalize them as their products of consciousness, and achieve comprehensive development in thinking, emotional resonance, and action transformation for the course content. It can be concluded that the practice of maker education must be established in the corresponding educational context, to propose a reasonable path for embodied education through a more student-centered approach.

3.1. Various Design Forms of Maker Education

Embodied cognition theory emphasizes that a deeper understanding and cognition of the world can be achieved through bodily participation and experience. In educational practice, maker education, as a special form of practice, focuses on involving students' bodies in the learning process to achieve a fusion of body and cognition. This teaching approach not only establishes internal connections between emotions, wills, and beliefs but also changes the traditional "vague ideology" of teaching and stimulates students' creativity and innovation. In classroom teaching, maker education should incorporate embodied elements into teaching tasks and use diverse teaching methods to present course content through multi-dimensional information such as visual, auditory, tactile, and kinesthetic senses. For example, interactive devices such as drawings, videos, VR, AR, and MR can be used to allow students to feel and experience the unique charm of maker education in practice, thus better understanding and mastering knowledge[12]. In this process, students' perceptual systems are fully activated, and knowledge is not only an abstract concept but also a practical experience with bodily sensations. This comprehensive and three-dimensional input of information can better stimulate students' thinking and imagination and promote the formation of diverse thinking methods. Therefore, the combination of embodied cognition and maker education can help students better understand and recognize the world, cultivate creativity and innovation, and better adapt to future social development.

3.2. Cooperative Learning Forms of Maker Education

The theory of "embodied cognition" suggests that bodily perceptual abilities not only derive from one's own feedback from the environment but also from the experience of others as intentional agents, which implies the importance of communication and interaction in education. Maker education courses typically involve group-based practical activities, emphasizing the spirit of collective cooperation. Collaborative learning requires clear roles for each student, promoting their development in multiple aspects such as knowledge, emotion, will, and behavior. The educational value of this interaction needs to be based on the students' external interactive experiences and internal reflective simulation. By conducting course communication and interaction in the form of group

cooperation, the embodied elements in the curriculum can be more fully explored, students' enthusiasm for collaborative learning can be stimulated, and students can more easily appreciate the sense of spiritual and mental gain. The value input of collaborative learning comes not only from external motivation but also from the power of internal emotional resonance. This can improve students' motivation and cultivate their noble moral character in practical social life, ultimately contributing to the potential "nurturing of creativity" and "nurturing of ethics" in maker education courses and achieving the sublimation of students' thinking and emotional identification. Therefore, emphasizing the spirit of collective cooperation and the importance of interactive communication in embodied teaching can further promote students' thinking patterns and emotional identification, achieving a higher level of education.

In addition, the embodied maker education and collaborative learning approach also contribute to the formation of students' educational identity. Educational identity refers to the consistency and sense of identification that students form with the values and beliefs of the school, educational content, and teachers during the process of receiving education. Through embodied maker education and teaching, students can better understand and experience educational content, thus better understanding and accepting the values and beliefs of education. This sense of identification helps students better adapt to future social and career development. Embodied maker education and teaching can also cultivate students' innovative spirit and creativity. In an embodied learning environment, students can explore new ideas and problem-solving methods through practice and exploration. The cultivation of this innovation and creativity helps students better respond to complex problems and challenges in their future careers and society.

3.3. The form of teacher-student interaction in maker education

In modern educational theory, it is believed that the imparting of curriculum knowledge should be based on communication, interaction, and collaboration between teachers and students to facilitate the transmission and innovation of knowledge. The educational process should involve experiential exchange among students of the knowledge, theories, beliefs, and concepts they have acquired in the educational environment. However, due to the significant differences in students' cognitive structures and educational identities, the embodiment of cognitive processes in maker education courses may also differ, and traditional maker education teaching methods lack the necessary interaction and tend to ignore the heterogeneity of students. The theory of "embodied cognition" emphasizes the experiential and interactive nature of bodily sensation and cognitive processes. Therefore, maker education should impart the meaning of knowledge to students through interactive forms of instruction, and teachers can design interactive activities that incorporate embodied elements to encourage students to fully participate in them. Through physical participation, students can closely combine the knowledge they have learned with their bodily experiences, forming a unity of body and mind, and making the learning process truly their own. In this way, students can mobilize their bodily experiences, focus on experiential exploration, and form cognitive representations of knowledge perceived through bodily sensation in the interaction between teachers and students, thereby subconsciously guiding students to establish correct values and outlooks on life and making maker education a lifelong beneficial social activity. Therefore, teachers in maker education should actively utilize their academic expertise and charisma, strengthen emotional and behavioral identification, and follow the logical generation of cognitive structures and educational identities. The teaching content should be designed from the perspective of the body and space, allowing students to experience the meaning of knowledge through specific interactive activities. In this way, students can deepen their understanding of the meaning and value of knowledge through bodily perception and interactive participation, thereby forming their cognitive representations.

At the same time, the combination of embodied cognition and maker education can also promote teachers' professional development. Embodied cognition theory emphasizes students' bodily participation and experience, and teachers need to have relevant knowledge and skills to create an embodied learning environment. Therefore, teachers need to continuously learn and update their knowledge and skills to better guide students in the practice and exploration of maker education. This

professional development can also promote teachers' personal and career growth, and enhance the quality and effectiveness of education and teaching.

3.4. Situational Setting Forms of Maker Education

Maker education emphasizes the close integration of the body, mind, and environment, considering them as an inseparable whole. Therefore, in teaching activities, maker education places students in real social situations, immersing them in the environment, and allowing them to experience and appreciate the internal value of the knowledge they have learned through practical hands-on activities. This approach helps students to understand the meaning of what they have learned more deeply.

Meanwhile, maker space educators guide students to participate in learning by creating a variety of communicative situations, such as physical scenarios, virtual scenarios, imaginative scenarios, and linguistic scenarios. In such scenarios, the perceptions formed by the body can affect the processes of learning and memory, and promote communication between the body and the environment. Teachers can stimulate students' initiative and curiosity, inspire their interest in learning and exploration, and help them develop critical thinking, collaboration, and innovation abilities.

In the context of maker education, embodied elements are essential. By creating practical and operational environments and incorporating embodied elements into the context for knowledge transmission, students can better experience, feel, understand, and master the knowledge they are learning. This teaching method not only helps students form a vital value identity but also allows them to acquire knowledge through participation, experience, and perception, and experience the internal emotions conveyed by embodied elements.

In summary, maker education has a strong logic in its teaching method. By closely combining the body, mind, and environment, it allows students to experience and appreciate the intrinsic value of the knowledge they learn in practical and operational contexts. Meanwhile, teachers guide students to participate in learning through various communicative contexts and mobilize their initiative and enthusiasm. In this process, embodied elements are indispensable, as they enable students to better experience, understand, and master the knowledge they learn, thus developing their creativity and practical skills. The advantages of maker education lie not only in allowing students to acquire knowledge but also in helping them form a vital value identity.

4. Conclusion

In the context of innovation and entrepreneurship, maker education plays an irreplaceable role as a new type of educational approach. Maker education not only helps students acquire practical skills but also guides them in achieving the integration of ethics and innovation from both theoretical and practical perspectives. However, there are still problems with subjectivity and insufficient emotional resonance in current maker education. To solve these problems, maker education can use the "embodied cognition" theory and adopt diverse teaching methods, such as multi-style, cooperative, interactive, and situational, to achieve the goal of education. The embodied cognition theory holds that "body," "mind," and "environment" are inseparable. Maker education can closely link the body with the environment to enable students to experience and appreciate the intrinsic value of their learning in practical situations. In addition, cooperative learning encourages collaboration and communication among students, enhancing their team collaboration abilities. Interactive learning stimulates students' interest and initiative, thereby improving their learning efficiency. Situational learning creates diverse scenarios to help students better understand the connotation of what they have learned. Through the application of these teaching methods, maker education based on the theory of embodied cognition can better achieve the goal of educating and cultivating individuals, helping students achieve the integration of ethics and innovation in practice.

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