The Design Model of Maker activity based on Embodied Cognition in the Primary and Middle School

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Abstract. Maker Education has received extensive attention because it can make up for the deficiency of innovative ability in traditional education. The theory based on embodied cognition more emphasizes the real situation of learning process, enhances students' interest of learning and promotes students' understanding of knowledge and teaching effect of Maker Education. Therefore, the paper proposes the design model of Maker activity based on embodied cognition in primary and middle school. It has been applied in practice, and summed up the practical suggestions of maker education activity based on embodied cognition by observing and evaluating this activities.

Introduction
The goal of maker education is to train students' innovative ability through solving specific problems; it pays more attention to “problem exploration and hands-on design”[1]. The real situation, design, iteration and results of the learning process are emphasized [2], which is gradually getting the attention of teachers and experts. At present, many scholars have conducted a lot of research on the maker education. For example, professor Zhi-Ting Zhu proposed eight major points of the maker education[3]: The nature of the subject, the complexity of the project, the abundance of resources, the interaction and the cooperation, the high intensity, the reasonable time schedule, the sharing of education and the novelty[2]; Lu-Yi Li et al. [4] expounded the path of green development of creative education, and Tong-Tong Li et al. [5] put forward the structure of professional quality of maker Teachers. Yan-Lin Zheng et al. [6] gave the essential goal of the maker education; Xu-Qing Wang [7] proposed the maker education model for STEM education. However, through the analysis it can be seen that people concerns over more technology and education framework, but rarely discussed teaching activities' design and how to use hands-on practice activities to promote the cultivation of innovation ability.

Embodied cognition provides a new theoretical basis for maker space and its activity design, pay more attention to how to participate and how to do affect on students' cognitive level, emotion and attitude through their body movements and communication[9], emphasizing the various physical perception of learning to understand and promote the internalization, for example, Hai-Feng Li et al. applied embodied cognition to the design of online learning environment[10].This paper intends to design maker activities for primary and secondary schools on the basis of embodied cognition.

An Analysis of Maker Learning Activity Based on Embodied Cognition

Theoretical Basis of Maker Activity Based on Embodied Cognition
The core concept of embodied cognition is: Human beings rely on their bodily functions, namely body anatomy, nervous system and sense organs, combining appropriate activities to interact and communicate with itself or outside world, which can help people understand itself and external world, and to form a perception of the world in the brain[9]. According to the elements of teaching embodiment, it can be divided into physical and imaginative, The parts of physical include direct, alternative, and enhanced; while imaginary parts include explicit and implicit. While the design of
maker activities emphasizes the actual operation of the body, therefore, if the activities can meet the needs of the body structure of the nervous system, sensory and motor system activities, then the actor will be able to better play their subjectivity and can also enhance the learning experience. Thus, activities designer pay attention to learners space, activities environment design can promote students' awareness, and get a pleasant sense of experience, which increase student initiative.

The Process of Knowledge Internalization Based on Embodied Cognition in Maker Activities

Combining embodied cognition and maker activities, considering the dynamic unification of students' emotional mental, physical property and environment, putting forward the process of knowledge internalization based on embodied cognition in maker activities, which formed with three levels: activity environment, body structure and cognitive mental.

Activity environment level includes maker space environment, communication environment and knowledge environment. In maker space environment, there are equipment and tools needed for maker activities, and the arrangement of these tools should have spatial, hierarchical and visibility, so that students can easy to inspire and associate. In communication environment, it’s really good if each group has independent space to avoid disturbing each other and have suitable share devices to discuss. The knowledge environment provides the knowledge required to maker activities, In order to obtain and verify the knowledge quickly, it can be either a book on a shelf or a digital form on a network, but requiring methods for quick access.

The body structure is the main link of embodied cognition using, it is consists of nervous system, motor sense and emotional attitudes, mobilizing the organs of the body and environment to promote cognition, it not only include its own senses and environment, but also infected with emotions of peers and teachers. Through the combination of various senses and the cognitive system, it can promote the understanding of information and the formation of innovative thinking.

Cognitive mind will be affected by emotional attitude and internal knowledge system, through the physical structure of embodied cognition, creative cognition can be formed. Although the three parts are divided into layers, in fact, they are a dynamic whole to enables learners to acquire the development of mind and cognition by interacting with environment and body.

Design Principles of Maker Activities Based on Embodied Cognition

The design of maker activities based on embodied cognition should follow some principles: (1) emphasize the role of teacher when designing an activity solution, design solutions should include roles, division of labor and responsibilities. Based on the theory of embodied cognition, teachers should be more involved in the division of labor, that mean teachers should be involved in the formulation of solutions, for example, group assignment requires the help of teachers. (2) The prototype of the activity should be communicated with the body (eye, emotion). After designing the plan, it is necessary to use 3D printer to print out the prototype, which is convenient for communication and modification, it is also the basis of the real work, embodied cognition emphasizes the perception of the limbs, and the observation and contact of the prototype will deepen the cognition, and the prototype of the work will serve as a tool for communication among the groups. (3) We should pay attention to the mobilization of members' enthusiasm in making works. Production link will play students' subjectivity, in the process of making the works to emphasize the interaction between the group, enhance the interest and positive feelings by body communication, the use of a variety of media and environment interaction channels can increase their cognitive; Teacher should pay attention to their own body, try to actively participate and guide students in the activities, and through the exchange of body language to communicate with the students in order to increase students' cognition.
Design Model of Maker Learning Activity Based on Embodied Cognition

Activity Object
The activity object is the teaching goal which the student achieves through the activity; it is the basis of activity task design and activity evaluation. Knowledge deepening and acquisition is only one dimension in the goal of maker learning activities, it more emphasis the cultivation of attitude and innovative ability, including the spirit of cooperation, Hands-on ability and the ability to solve practical problems.

Activity Tasks
The activity task is based on the aims and make aim concrete in each specific task link, students can achieve their goals in the process of completing the project. Task design should not only consider the characteristics of learners, but also prepare a variety of task forms, so as to enable all students to move, and personally practice, not only to consider interest, but also consider the knowledge and identity, so that all students have the opportunity to show their own ideas.

Design and Implementation of Activity
The design and implementation of activity includes three parts: design solution, tools preparation and prototyping, in the process of implementation, teacher should combine the theory of embody cognition so that students will play a dominant role. Teachers should also have body movements, such as gestures and facial expressions to encourage students who are thinking and making, play the role of collaborative coaching, and through body voice to improve the students' positive emotions. The organic combination of the environment and the body allows students to enhance their interests and develop their own creativity in the perception of environment and communication, however, it should be noted that there is a distance between the different groups, but not too far away. Otherwise, it is difficult to communicate with each other between different groups, which are not conducive to the perception and emotional stimulation. At the same time, teacher should give prototype by using 3D printer, letting students play the role of cognition in the visual, auditory, tactile; the partners should measure, move, touch and observe each other, so as to promote the communication with each other at the level of body cognition, improve understanding of product manufacturing, and exchange knowledge in embodied condition.

Activity Evaluation
The evaluation of maker activities based on embodied cognition include the evaluation of finished product display and communicate, it also includes evaluation of learners' body language, emotional motivation and student interviews. In this way, we can fully understand students' training effect of innovative ability and determine the validity of the task form.

Case of Maker Learning Activities Design Based on Embodied Cognition

Examples of Maker Activities
In a maker space, students build a “land aircraft carrier” for the Technology Festival, the aircraft carrier carry a model plane and a Single-chip robot, the aircraft carrier can walk along the fixed route, the model plane will go to survey and return the information of obstacles to the Single-chip robot when the aircraft carrier meets obstacles, then, the robot will go out and clear the obstacles, after that, the carrier will continue going. Making “Land aircraft carriers” requires students to design, make and decorate together in different groups. The whole activity design is as follows:

1. Activity object. In terms of knowledge and skills, students should master the cosine theorem and explore knowledge related to kinetic energy; In terms of operating ability, students should be familiar with animation production in PowerPoint and be able to measure and assemble boards accurately; In
terms of thought and attitude, students should improve their sense of cooperation and ability to coordinate work.

2. Activity tasks. Firstly, complete the basic functions of the aircraft carrier, including aircraft carrier measurement setting of volume, splicing of structure, and packaging of external design, printing, lighting, decorating and so on, finally complete the production and testing.

3. Design and implementation of activity: (1) design the total solution. Divide the students into three groups, each group 3~4. First of all, there should be a round table and an electronic whiteboard area to discuss the body of the carrier, the position of the wheel, and the shape and size of the body, and record and report on the whiteboard, planning the total solution, in this process, teachers are also the members of activities, they should pay attention to participate in activities and complete task with students. (2) Division of labor by group. The first group is responsible for making presentation to show the functions of aircraft carrier, as well as the walking routes and operations in the festival. The second group is responsible for setting up the overall shape of the car according to the size of the aircraft model. The third group is responsible for designing the theme poster and making it out with the help of computer and drawing software, it should be noted that the shape of each surface of the aircraft carrier, students should find appropriate solution when meeting irregular figure, finally, print it with acrylic material and paste it on the “aircraft carrier”. (3) Tools preparation. First of all, determine the necessary equipment, safety considerations should be taken into account in equipment operation; commonly used small tools should consider the sharing between groups, should pay attention to the location of the display, reduce the time to find the equipment and the inconvenience of taking and placing; it should be considered the sharing of small tool, pay attention to the placement, reduce the time to take and place the equipment. (4) Prototype making. Using 3D printer to produce prototype, which provides the basis for communication and discussion before production, and provides guidance for production in the later stage. In the process of making, the members can communicate with each other in the active area, report the progress, and know the information about other groups in time.

4. Activity evaluation. Activity evaluation includes summary evaluation and process evaluation, summary active evaluation refers to the finished product and the degree of fit with the evaluation requirements, in addition, the beauty of color usage; process evaluation mainly refers to the students’ internal motivation of speech act and the coordination between groups. The evaluation of maker activities based on embodied cognition include the evaluation of finished product display and communicate, it also includes evaluation of learners' body language, emotional motivation and student interviews. In this way, we can fully understand students’ training effect of innovative ability and determine the validity of the task form.

The Result Analysis

The results of the above practices show:

Embodied Cognition Can Promote Students' Initiative

Throughout the activity, students showed positive interest and attitudes, and there was also sufficient communication between groups and all groups complete the task successfully. In the course of activities, students communicate actively, members of the group always keep in touch with each other, continue to test and show great interest, as shown in Figure 1. Emotions between team members play an important role in collecting and communicating inspiration, teachers can feel the high interest and strong sense of participation in the conversation with the students, the students want to contribute their ideas to the group actively.
Teachers Become Guides and Inspiration to Participate Activities

Teachers are the guides and helpers in the whole activity; besides providing help for students they should also pay attention to their participation and hands-on practice. The teacher is a member of makers, their participation and emotion will have a great influence on students' mood, therefore, teachers should try to use “smile”, “nod” and other postures to enhance students’ interest in activities.

Physical and Emotional Communication between Students Can Increase Motivation

Students will improve their interests and enthusiasm through physical communication, during the activity, teachers should also observe the students' character and expression, let more active students contact with the quiet students, this can influence group partners, improve the physical and participation of quiet students, which can promote their cognitive level.

Conclusion

Maker activities are a new form of education. Taking full advantage of embodied cognitive learning theory can promote the effect of maker education activities. Therefore, the paper proposes the Design model of Maker activity based on Embodied Cognition in primary and middle school, and it has been applied in practice, through observing and evaluating these activities to sum up the practical suggestions of maker education activity based on embodied cognition, these can help teachers design maker.

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References


