

Practical Research on Robotics Teaching in Elementary School Based on 4C Teaching Method: The Example of LEGO Educational Robotics

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Abstract: With the rapid development of artificial intelligence and robotics industry, robotics education is gradually gaining widespread attention, and students can exercise hands-on and collaborative communication skills through learning robotics-related knowledge and skills. This study combined the robot curriculum and 4C teaching method, and carried out robot teaching based on 4C teaching concept in N school, so as to promote the overall development of students. A review of literature and interviews with front-line robotics teachers were conducted to understand the current problems of robotics teaching and to give corresponding suggestions as a reference for the practice of robotics teaching in elementary schools.

1. Introduction

In recent years, the General Office of the State Council, the Ministry of Education and other central authorities have issued many documents to attach importance to the development of STEAM education. National policy is the best vane of education, which shows the importance of STEAM education. In China, STEAM education is often associated with creative education, interdisciplinary education, robotics education, and so on. The concept of STEAM education is well reflected in robotics education. With the rapid development of intelligent robotics technology, robotics education has become a teaching hotspot that has received much attention at home and abroad in recent years, and robotics teaching has been more and more accepted by the education circle in training learners' ability of operation, cooperation and communication ^[1].

This study analyzed the current situation of robotics teaching in primary schools and applied the 4C teaching method to robotics education classrooms for teaching example analysis. We hope to improve the robotics teaching based on the 4C teaching method, and to help the future development of robotics education in primary schools in China.

2. The Current Situation of Robotics Teaching

Through literature review and interviews with front-line robotics teachers to understand the current problems of robotics teaching, compared with foreign robotics teaching research, China's robotics teaching research is still in its initial stage.

In terms of teaching mode, Chinese scholars mainly try to explore the application methods, strategies and dilemmas of robotics teaching at the classroom level based on the interdisciplinary and interesting characteristics of robotics, in order to promote the development of robotics education, give full play to the value of robotics teaching, and promote the overall development of students while improving their learning ability ^[2].

In the field of teaching reform, it mainly involves the reform of teaching content and teaching methods. In terms of teaching content, it is still necessary to expand and explore in breadth and depth. Instead of just learning the basic knowledge, students should be guided to ask questions and think about their understanding of robotics education ^[3].

In terms of teaching methods, teachers should focus on guiding students to learn by doing, so that students can get better theoretical and skill training, and are committed to improving students' experimental level and theoretical application ability through independent practical operation training ^[4].

In the field of teaching policies, China is paying more and more attention to robotics education, and robotics teaching has become one of the important ways to educate innovative talents. The policies related to robotics teaching have made clear specifications and requirements for the curriculum and teaching materials of robotics teaching in China.

3. 4C Robotics Teaching Method

The main teaching modes of robotics education at this stage are: 4c teaching mode, 5e teaching mode and PBL teaching method ^[5]. This research analyzed the robot classroom teaching based on 4C teaching mode. The 4C teaching method is based on the teaching process and results of LEGO education, which is the same as the core concept of constructivism advocated by American child psychologist Piaget. The cognitive development process of children can be transformed into their inner consciousness through the perception of the outside world. The original knowledge is gradually integrated into the new cognition, through continuous assimilation and adaptation, so as to transform the original cognitive structure and establish a new cognitive structure ^[6]. The 4c teaching method created by LEGO Education is based on constructivism and aims at learning for children's creativity. It consists of four stages: connect, construct, contemplate and continue, which effectively stimulates learners' curiosity and creativity and is an effective teaching method for cultivating students' creative thinking ^[7].

3.1 Connect

Connecting new knowledge points with learners' original knowledge points, through simple narration or communication, could stimulate children's interest and connect existing knowledge points in children's brains, and prepare for a new teaching experience. The core content of this paper is to link theory to practice, not only to learn theoretical knowledge, but also to use scientific knowledge, and to train students to think and experience from it, so that children can establish a close connection with real life. By taking real-life problems in everyday life as a starting point, students find solutions to real-life problems by linking them to their knowledge ^[8].

3.2 Construct

This means constructing things in the real world and combining knowledge in the mind. By allowing learners to carry out bold imaginary experiments in the process of practice and thinking, children could conceive their own solutions and become the creators of learning rather than the recipients of science and technology. By identifying problems and solving them step by step, learners

develop their programming skills and their ability to deal with real-world problems on a continuous basis.

3.3 Contemplate

This means to summarize and communicate what we have learned. This includes: What did the students get and what did they gain? What problems did they encounter in the process of learning? how did they overcome them? and so on. In the teaching process, teachers should always pay attention to the students' psychological state, and guide them to solve problems appropriately at the right time.

3.4 Continue

The teacher should always be aware of the students' psychological state and guide them to solve the problem appropriately. Through students' reflection on what they have learned and what can be improved, they can enter the next stage of learning, which promotes reflection on learning, further stimulates creativity, and enhances the ability to innovate.

4. Robotics Teaching Practice Based on 4C Teaching Method

In this paper, we took the LEGO WeDo2.0 programming set as an example to complete the basic experiment "fan" project, and explained in detail the design of robotics classroom teaching based on the 4C teaching method.

The main content of the N school robotics club curriculum is based on LEGO WeDo2.0 building and programming. The curriculum is for primary school students in grades one, two, three, four and five. In the process of research and development, this study tried to integrate the 4C teaching method into the daily teaching process and carry out educational teaching activities.

4.1 Target Group

In elementary school N, robotics education is taught in the form of student club classes, and the students are mainly from grades 1-5. In order to achieve better teaching effect, the school divided students of different grades into basic classes and promotion classes. The main difference between the classes is the depth and breadth of knowledge. Junior students learn basic robot construction and programming, while middle and senior students learn higher level and more difficult construction and programming writing. In this study, students were randomly grouped in pairs in a lower basic class prior to the class. During the course of the lesson, the students of all ages were co-taught. The group cooperation started with disagreements and disputes, but through continuous communication and friction, the students' sense of collaboration gradually increased, and the group members would discuss and deal with problems together and share their successful experiences of cooperation with other groups. This can cultivate students of all ages' hands-on skills, awareness and ability to communicate and collaborate, and their confidence, patience and concentration.

4.2 Teaching Content and Learning Themes

The basic experiment "Fan" project task is to let students learn how to use the motor power block in the LEGO robot program block.

4.3 Learning Tools

The learning tools are mainly LEGO WeDo2.0 programming set and laptop. The LEGO WeDo2.0

programming set contains five categories: structural components, connecting components, moving components, decorative components and electronic components. In the "Fan" course, we mainly use structural components (sheets, bricks, beams, etc.), connecting components (pins, bushings, half-shaft bushings, etc.), moving components (unit axes, etc.) and electronic components. As shown in Figure 1, students voluntarily use decorative components to decorate and match fans according to their own needs.



Figure 1: Build a simple fan model with the WeDo 2.0 programming suite

4.4 Teaching Methods

In the process of completing the task, the students' interest in learning is mobilized through the crossover of demonstration teaching method, lecture method and group collaboration teaching method^[9].

4.5 Teaching Process

Students were required to first build the LEGO model, connect the model and equipment, and finally program the motor to make the fan rotate at different speeds. In this stage, students also had to do the initial construction of the fan and make it more aesthetically pleasing and functional while ensuring that the fan could run safely. As shown in Figure 2, The teacher acts as a guide throughout the process, helping students to sort out their thinking while they think about how to solve the problem on their own.

Step 1: Firstly, multimedia introduced a picture of a fan, which we often see in hot weather, and led students to be interested in the construction and operation of the fan.

Step 2: Students worked in groups and spent about half an hour to finish building the fan. They need to consider which LEGO parts can be used to make the fan blades more stable and the limited Lego parts can be used to make the fan beautiful. Before starting programming, students first need to understand the program blocks, motor power blocks and their basic roles for this course. After the understanding is complete, they connected the models and equipment to turn the fan. The group will further explain to each other how the fan works.

Step 3: After completing the basic programming, students can try to make the fan spin at different speeds and then stop it. The teacher further guided the students to think about how to design the fan blades to make the fan wind stronger. Is there a relationship between the number of fan blades and the wind of the fan?

Step 4: The teacher asked students fan leaf can also be used in life where? What are their functions? After answering the questions, students should be guided to develop good habits and learn to record the fan program in a reasonable position and name it, so that they can better review the previous

learning content in the future learning tasks. Finally, after each class, the computer was shut down normally, and the assembled parts were removed to the fixed position in the box.

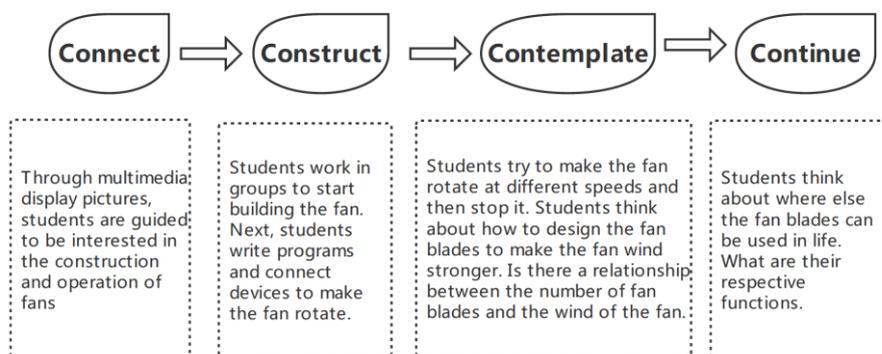


Figure 2: Teaching process of "fan" based on 4c teaching method

4.6 Evaluation

At last, teachers' comments, group mutual evaluation and students' self-evaluation were used to check students' achievements. Each group introduced and demonstrated their own fan and the effect of programming. The remaining groups learned from the strengths of other groups and complemented the weaknesses of their own. At the same time, students had to explain what responsibilities they had taken in the project and how well they had completed it. Then students evaluated themselves. Finally, the teacher will make a comprehensive evaluation according to the division of work, the completion of the model, the creativity of the model, and the degree of programming writing.

4.7 Reflection on Teaching

In the process of the project, the students' feedback and classroom interaction showed that they were very interested in the basic experiment and enjoyed debugging the program and making more detailed modifications. Team members can preliminarily learn to cooperate and communicate with others, and better integrate themselves into group cooperation, building and programming ^[10]. During the teaching process, there were some unexpected incidents, such as the fan blade could not be fixed after using smooth pins, and the fan blade could not be rotated when it was completely fixed. In addition to guidance, teachers should give students some encouragement according to the actual situation in the teaching process.

5. Conclusion

Students are motivated by the robotic teaching in elementary schools based on the 4C approach, and they have expectations for the future and enthusiasm to continue learning. In such a process, students' learning forms a virtuous cycle that spirals upward.

In the process of teaching robotics, teachers should set up appropriate contexts according to students' age and psychological characteristics to elicit students' emotional resonance so as to obtain the best learning effect ^[11]. Teachers should connect students' existing knowledge and interests with the standards and knowledge points, expose them to an open-ended challenge or task, encourage them to ask their own questions and think about problems from multiple perspectives and in a holistic way, and explore various aspects in the process.

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