International Journal of Engineering Education Vol. 33, No. 3, pp. 1104–1109, 2017
Printed in Great Britain

0949-149X/91 $3.00+0.00

The Study of Teaching Mode in Building Blocks Based on K'NEX*

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Building blocks are deeply loved by children. It has a great effect on children's physical development, social cognition and so on. And it is also paid more and more attention by domestic and international scholars. But the research of building blocks mostly focuses on specific cognitive promoting function. However, the instruction of building blocks only remains at superficial level. This paper focuses on the teaching of building activity based on K'NEX blocks. And it puts forward the teaching mode in building blocks named Q4E.The details include questioning, exploring, explaining, expanding, evaluating. At the same time, the researchers held the activity named "Young Engineer" in China Science and Technology Museum to explore the feasibility of Q4E teaching mode. The study also wants to provide reference for the teaching of building blocks.

Keywords: K'NEX blocks; teaching mode; Q4E

1. Introduction

As a teaching appliance, building blocks are deeply loved by children, and they are helpful for the children's intelligence. Blocks first appeared as a teaching appliance named "Froebel Gifts" which are designed by Friedrich Wilhelm Frobel. Children can easily understand the relationship between the whole and the parts through the "Froebel Gifts" operation, and develop imagination, creativity, learning, reasoning, language, and strengthening peer exchanges [1]. With the development of the society education, the types of building blocks are increasing in numbers. At the same time, more and more educators recognize that the building blocks play an important role in the development of children. By building blocks, it is helpful to the children in the four areas of physical, emotional, social and cognitive growth [2]. Through the experiment, it finds that block building has a great effect on the development of spatial skills at the same time [3].

Because of the effects on children's development, building blocks received extensive attention of many researchers and teachers home and abroad. Wolfgang, Stannard & Jones find that building blocks in preschool is helpful to math skills in high school [4]. By observing, Beth M. Casey put forward that both unit and large hollow block play may supply young children abundant opportunities and experiences and they encourage the development of society [3]. In addition, the pre-school education expert Liu Yan, in the General Theory of Children's Game, puts forward that the building blocks provide the ideal characterization methods for the infants' integration and expression of their understanding and feelings of the world around, helping to enrich and deepen the understanding of the society and life. At the same time, it is good for young children's social learning [5].

With the help of the blocks, we are looking forward to building blocks can play a more effective role in the student's development and study. It finds that engineering design is helpful to the learning of science in the previous research [6]. Yanyan Li has carried on the experiment to try to combine engineering education with blocks based on Lego [7]. Sheppard, Macatangay, Colby, and Sullivan have supply the a general model of engineering design and it includes eight steps: identify the need or problem, research the need or problem, develop possible solution, select the best possible solution, construct a prototype, test and evaluation the solution, communicate the solution, redesign [8]. Also, we will use the researches for reference to carry on the experiment.

By literature research, we find that the studies of building blocks mostly focus on blocks that play the roles in the development of various aspects. At the

* Accepted 28 January 2017.

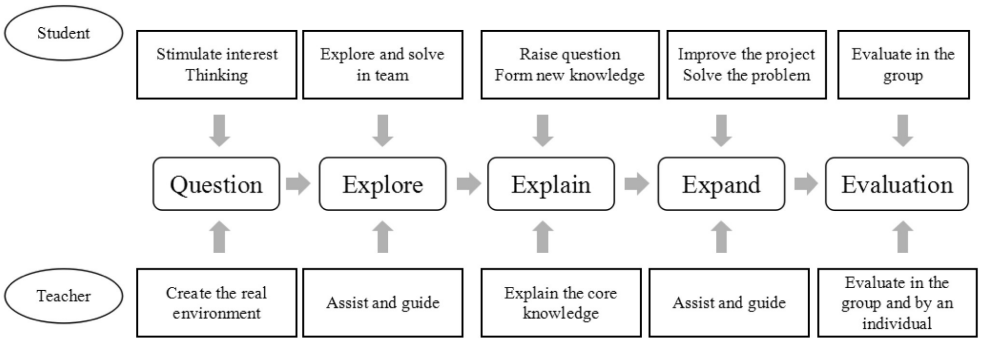

Fig. 1. The Flow Chart of the Teaching Mode Which Named Q4E about Building Blocks.

same time, the studies may pay more attention on which kind of environment and intervention the teachers should provide to support during the building. Besides, the objects of studies are basically concentrated on pre-school children. As we know, the mixture of the engineering education and blocks building is more benefit to the development of children, not only the science knowledge, but also the skills. Moreover, there is less study. Therefore, in order to make the children's ability in every aspect to fully exercise and training during the building blocks, this article puts forward the classroom-teaching model of building blocks with K'NEX blocks as the carrier to combine the blocks with engineering education.

2. The teaching model in building blocks based on K'NEX

As the creative building blocks, the structure of the K'NEX is mainly composed of grooves and ridges and the shapes are mainly about snowflake and rods. Due to its ingenious structure and the freedom of linking when building model, K'NEX has good spatiality. The model of K'NEX contains four sorts of features: science, happy, thinking and innovation. Compared with the traditional cascading or stacked blocks, K'NEX gets rid of the lack of space ductility, and has more creative and ductility on the structure and design, thus it has a great effect on improving participants' ability of innovation. Meanwhile many fields such as mathematics, physics knowledge are blended in among the building, realize "Studying during Playing".

In 2006, the innovation model of K'NEX in mainland started to develop. Since then, a variety of courses and competitions emerge in endlessly. In June 2010, the first Beijing K'NEX technology innovation competition attracts 16 youth teams to participate in, and the students also had a good score in the Asia Pacific K'NEX creative contest [9]. However, domestic building activities exist in the form of toys to some extent, entertainment is stronger, and the consciousness of education is weak. In the course of traditional building blocks, the enthusiasm and initiative of the students are poor. The students pay more attention on imitation. At the same time, the curriculum quality of the teachers needs to improve. They didn't put the students' autonomy in the first place, as well as the ability of inquiry. Therefore, the paper puts forward a new teaching mode for building blocks.

2.1 The teaching model named Q4E

Based on K'NEX, the study focuses on the activities of teaching process, and building the teaching mode of the building blocks to make full use of the strength of K'NEX. On one hand, the model of teaching promotes learning professional knowledge. On the other hand, it promotes the development of multiple intelligence and the ability of scientific inquiry. The teaching mode is defined as Q4E.The details include questioning, exploring, explaining, expanding, evaluating (as shown in Fig. 1).

2.1.1 Question

Teachers establish a scenario and then guide students to think and solve problems by asking questions according to it. Constructivists submit their views that knowledge survives in specific, situational and appreciable activities, thus learning should occur in the real social situation [10]. At the same time, by using scientific principles, technological tools, and mathematical computing, education expects students to solve real question of life [11]. Situational learning process can stimulate students' internal learning motivation and cultivate their exploration spirit. However, we should also pay attention to the skills when creating the situation. Herrington & Oliver have put forward the guide of the studying environment that asks us to provide real environment [12]. Therefore, we supply the situation to the students what should not only stay close to real life but also provide enough space

for students' exploration to deliver positive values and embody humanistic feelings as far as possible.

We need to note the question here is closely related to the real life. Moreover, it is concerned with the content that students will study. Questions involve the core knowledge of the course, teachers provide enough resources and students only need to solve the problem which is most directly related to the course content. At the beginning of the course, orienting at questions can stir up the desire of the students' investigation, cultivate student' learning interest and foster students' thinking ability.

2.1.2 Exploration

After teachers raise the questions, students solve them according to the existing knowledge. Meanwhile, in the process of solving questions, students should record data and new questions. Problem-based learning (PBL) aims at settling the problems, constructing new knowledge which is behind the problems and developing students' skills to solve problems through learners' teamwork [13]. By constantly trying, it can not only stimulate students' interest in study and strengthen learning motivation, but also develop the critical thinking in the learning process and inspire the enthusiasm of students [14].

This is the innovation of Q4E mode. Constructivist learning theory claims that learning is a meaning construction process (educational psychology). Studying should occur before the teachers' explanation. Students need to discover new knowledge, try to solve the new problems and do meaning construction through personal studying. Also, in the form of group, integrating one's own knowledge and settling the problems through partner cooperation could cultivate students' cooperation spirit and interpersonal skills.

2.1.3 Explanation

After students' early inquiry learning, teachers should solve the problems in the learning process specifically and supplement knowledge according to the objective of the lesson. Based on the early practice learning, students will have a deeper understanding of knowledge and enhance the learning efficiency and enthusiasm.

Although the students are the main body in the process of learning, we shouldn't ignore teachers' role in class. In this part, we adopt the traditional teaching method. Teachers explain through oral language and all of these are aimed at knowledge instruction. This approach has its own advantage. It is conductive to imparting systematic knowledge on one hand and bringing teachers into play leading role with effective control of teaching process on the other hand.

Students will have a deeper understanding of the problems encountered in the inquiry learning and the core knowledge of this course through teachers' explanations and instructions. Moreover, they could have a more thorough understanding of how to apply the knowledge to building K'NEX.

2.1.4 Improvement and expansion

This segment is divided into two parts. One is the improvement that students renovate their early inquiry learning task after teachers' explanation, and the other is expansion that students have an open discussion and build the model to solve practical problems according to the aim of curriculum.

This segment is the extension and application of the preliminary study. Combining intellectual content with practice could not only consolidate and deepen knowledge aims, but also exercise the students' ability to build. The students' abilities of practice, imagination and spatial logic are all benefited from it.

2.1.5 Evaluation

Evaluation is the process of making a scientific judgment on the development and changes of students' learning through the use of scientific means and methods on the basis of systematic and scientific collection, collation, processing and analysis of students' learning information [15]. Evaluation plays important role in the teaching mode of building blocks. Teachers make their comments on groups according to students' complete works. Moreover, self-evaluation is encouraged at the end of the curriculum. Teachers will guide students to evaluate their self-awareness in the aspects of skills, knowledge and cooperation and encourage them to impose new questions and opinions.

Building blocks are of benefit to knowledge learning as well as the development of students' multi-intelligences. In 1983, Gardner, an American developmental psychologist, put forward the theory of Multiple Intelligences. He thinks there are at least seven kinds of intelligence in human life, such as linguistic intelligence, logical-mathematical intelligence, spatial intelligence, bodily-kinesthetic intelligence, musical intelligence, interpersonal intelligence, and intrapersonal intelligence [16]. So, in the process of building K'NEX, the design of evaluation should be aimed at the specific forms of activities. For example, the evaluation which is occurred in the part of exploration and discovery should focus on the students' ability of thinking logically and improve the link of expanding. Teachers focus on evaluating the students' ability of interpersonal skills and space structures.

2.2 The advantages of Q4E teaching mode

Q4E teaching mode is proposed in view of the building blocks teaching. Based on the constructivism learning theory, it emphasizes knowledge is built by the individual too. It attaches great importance to the creation of the learning situation and suggests situation should contact with the real life. Meanwhile, the mode focuses on the cultivation of students' ability of exploration and problem solving. Of course, learners' internal motivation should be considered too. The mode advocates doing building blocks in the form of team in study methods so that this can develop students' consciousness of teamwork and interpersonal skills. Q4E has obvious advantages in the whole process of teaching. Firstly, the teaching mode emphasizes teachers' role. Before explanation, teachers will raise questions and let students think about the questions independently. This could cultivate students' exploring spirit, and guarantee the systemic knowledge. Furthermore, on the basis of systemic knowledge, students could explore the questions deeply. Secondly, in Q4E, emphasizing the expansion of practice after learning means that we will spend most of the time on the improvement of expansion link so that students can study and develop their ability in activities. If students do independent exploration completely, the systematic and integration of knowledge can't be guaranteed. Similarly, fully taught by teachers can't assure the quality of exploration. So, it will be better that students do some research after teachers solve some simple problems in exploration and students have a systemic understanding about knowledge. Thirdly, evaluation is added into the Q4E mode. Teachers make their comments according to students' complete works. It could help teachers to gain a comprehensive understanding about the teaching effect. Also, students can get feedback from the teachers' evaluation so that they can recognize themselves correctly. Last but not least, Q4e mode focuses on the development of students' linguistic intelligence. Students are encouraged to raise some questions and opinions after listening to others.

3. Teaching example of K'NEX

According to the previous teaching mode of K'NEX blocks, we organized the activity named "Young Engineer" in China Science and Technology Museum to explore the feasibility of Q4E teaching mode. "Young Engineer" is a building activity based on K'NEX to cultivate the ability of practicing and innovation. Each activity will choose a topic to train the ability of building blocks.

3.1 The preparations of "Young Teenager"

The activity of "Young Engineer" is divided into eight lessons, for two and a half hours at a time. There are two lectures in a teaching unit, 4 units in total. The students are children of 9–12 years old. In the course, they were divided into four groups randomly. The theme of this course is "transmission", which is divided into four units: gear transmission, rope belt transmission, chain transmission and comprehensive practice.

3.2 Teaching examples of "Young Teenager"

According to the teaching mode named Q4E, we take belt transmission, one of the units, as an example. The specific teaching cases are as follows.

3.2.1 Question

At the beginning, the teacher played the video "Three Monks" and then raised a question about how to help the monk carried the water from bottom to the top of the mountain. Through watching the video, not only the course introduced the rope belt transmission, but also it guided the students to think about why the monks had no water to drink. By the form of animation, the course stimulated students' learning motivation extremely.

After that, the teacher provided the students some simple rockeries and buckets which were built by K'NEX so that students could solve the problems based on K'NEX. The students could exclude the interference of other unnecessary problems, thinking the most important question directly. At the same time, the teacher provided the ropes, belts and other equipment that might help the students solve issues.

3.2.2 Exploration

After the teacher put forward the questions, the students thought and discussed by group about what kind of equipment could be used to carry the water to the top of mountain. The team would use the K'NEX provided by teacher to have a try and find out the way of solving the problems. For example, the second group used the chain as the tool to transport the bucket at first. However, the students found that it was not stable so they changed it for the rope. Without the teachers' guidance, the students learned knowledge independently and enjoyed the meaningful process.

At the beginning of the course, students found and solved the problems autonomously. This not only helped them to understand new knowledge, but also improved students' ability to explore and innovate.

3.2.3 Explanation

The teacher organized the students to report after the inquiry activity. The content mainly included: the design of works, the using of knowledge, the way of finding and solving new problems. After reporting, the other teams would ask questions and analyze the advantages and disadvantages of building works. Two groups chose chain transmission, and the others chose rope belt transmission in the showcases. Then the teacher guided the students to think about the differences between the two types of transmission. On this basis, the knowledge of rope belt transmission should be explained systematically by the teacher. Also, teacher will add the new content to enhance the students' understanding.

On one hand, the explanation after research would correct students' exploration in the process. On the other hand, this would fill the holes in knowledge and were beneficial to systematic study.

3.2.4 Expansion

The team should improve the construction of the prophase task and solve the problems in the process. The activity was aimed to develop students' multiple intelligences with the help of K'NEX. Therefore, the course spent a lot of time on the design of structures, and divided it into two parts. The first part was arranged at the end of first class. This part put forward that students should build a manual spinning wheel individually. One of the reasons why the students built it by themselves was that they have certain foundation before, the other is that this could cultivate their independent operation ability. The second part of the building activities was arranged in the second course. It would take two and a half hours to put forward and solve a new problem that if there was no water for the other monks that lived in the opposite hill, how could they get help. Students discussed in small groups at the start. After drawing the design drawings and considering the design principles, they could begin to build the blocks. There were large amount of tasks during the second part, therefore team cooperation was needed. The activity had requests for operation, language expression, mathematical logic and space structure.

3.2.5 Evaluation

The evaluation of the teaching unit involved mainly included the following aspects.

First, in the exploration link, the teacher evaluated students' mathematical logic intelligence through constructing summary sheet about the understanding of task and the clarity of the thinking as well as the ability of processing the existing information.

Second, in the explanation link, due to the students' reporting activities, teachers' evaluation is aimed at students' verbal ability, verbal fluency and presentation time.

Finally, in the expansion link, in order to understand the students' visual spatial intelligence and the ability of independent inquiry, teacher evaluates on the scale which covers the length of time, the number of building blocks, the innovation and the level of finish.

3.3 The result of Q4E

In order to understand the implementation effect of Q4E teaching mode, activities are evaluated from the scale during class and the satisfaction questionnaires after class. It can be seen from the scale during class that: (1) Most of students have certain promotion in the ability of mathematical logic: in the process of the whole class activities, students strengthen the understanding of building task gradually ,and can make a rapid response on the issues they understand. (2) Students' awareness of inquiry is enhanced: in the later stages of the curriculum implementation, most of the teams start to constantly try new solutions. For instance, students come up with a method that can combine gear with chain perfectly. At the same time, they will put forward targeted problems in the process. (3) The students attach importance to interpersonal communication. At the end of the course, students make progress in the participation of groups and the enthusiasm in the discussion. After class, the activity is evaluated from the satisfaction questionnaire to know the students' learning conditions. On the side of satisfaction of the teaching mode, the questionnaire survey indicates that 66.7% of students are satisfied with the curriculum of building blocks. Meanwhile, 77.8% of students hope the mode can be used on other courses. On the side of promoting students' development, there is a question that "I think I can find more new problems in the course". 50.8% of students choose "quite agree", 49.2% of students choose "agree". In answer to the question that "the course teaches me to use new ways to think about what we have observed" 34.4% of students choose "very agree" and 35.0% of students choose "agree".

4. Conclusion

The Q4E teaching mode includes questioning, exploring, explaining, expanding, evaluating. The mode provides a reference on building blocks. In the mode, as the main body, the students are encouraged to explore independently. At the same time, teachers' teaching is a core part too. The guiding role of teachers must not be ignored in the teaching

process. The course which is based on the teaching mode greatly promotes students' enthusiasm of learning. Through the questionnaire data, we find that the new teaching mode can help students to discover new problems. The course is more interesting, and it promotes the development of students' multiple intelligences, so it is feasible.

However, we need to focus on some links in practice. In the process of the implementation of the curriculum, content is still the main body in the design of courses. We should not solidify the teaching link blindly.

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