Research on School Information Technology Education Based on STEM

Xiaodong Huang[a,*], Qin Wang[b]

Capital Normal University, Beijing 100048, China

[a] hxd@cnu.edu.cn, [b] huiyidt@126.com

*corresponding author

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Abstract: The digital era witnessed STEM education, which is suitable for being applied to guiding information technology teaching with its ideas of cross-discipline, product design, etc. This paper first introduced the connotation of the STEM education and the current situation of information technology teaching. Then it presented the implications of the STEM education for information technology teaching in Chinese primary, middle and high schools from four aspects, which are setting situations and identifying problems, integrating information and analyzing problems, practical operations and solving problems, design and creation and transfer application. Finally, it proposed to renew teaching contents, integrate resources, and strengthen cooperation among teachers.

1. Introduction

With the development of the Big Data, IoT (Internet of Things) and AI (Artificial Intelligence), digital technology is penetrating into every aspect of our life, and it has been closely combined with various industries and fields to reconstruct the internal structure of industry, to promote industrial benefits and to push human beings forward to the digital era, which has put forward higher request for talents born in the new century. STEM education [1-7] has been developing in this context. It advocates eliminating and breaking disciplinary boundaries and solving problems when experiencing activities, so as to cultivate students' practical ability and creativity. Information technology (IT) education in schools at all levels aims at providing students with opportunities to experience information and cultivating their interests. Both STEM and IT education emphasize experience of students. The application of STEM to IT teaching will advance the development of IT education in primary, middle and high schools.

STEM is the abbreviation of Science, Technology, Engineer and Mathematics. It originates from the programmatic recommendations [1] for "Science, mathematics, engineering and technology" education first proposed by the National Science Foundation of the U. S. A. in 1986, which reflected on how to cultivate talents in time of fierce international talents competition and the demanding task of enhancing economic development. Since then, people have an increasing interest in the research of STEM, and in recent decades it has spread to China, Japan, Germany, United Kingdom and other countries.

STEM education emphasizes the integration of science, technology, engineering and mathematics education. Nowadays, many current education problems cannot be solved by a single subject alone and must rely heavily on multidisciplinary coordination. By highlighting the integration of science, engineering, technology, mathematics and art, STEM education breaks the original disciplinary boundaries, pays attention to the process of students' experiencing learning activities, and directs students to use skills to solve life problems. Therefore, STEM education can enhance students' implementing capability and practical ability, helping to inspire their innovative thinking.

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2. Current Situation of IT Courses in Chinese Schools

In 2012, the Information Technology Education Committee of the Chinese Association for Educational Technology formulated Standard for Basic Education of Information Technology (2012) [8], which indicates that "The general goal of Information Technology course in basic education stage is to cultivate and improve students' information literacy which is mainly manifested in the ability of using information technology tools to acquire, process, manage, express and exchange information, ability to express ideas, exchange ideas, collaborate and solve practical problems in learning and life on the basis of knowing well and utilizing technical conditions and circumstances." The information literacy can be summed up as students' practical ability, evaluation ability, problem-solving ability and social responsibility.

IT is a discipline that attaches importance to practice and operation. Traditionally, the IT teacher simply regards IT as an operation skill training course. They ignore the cultivation of students' information legacy, causing them to feel tired and lose interest in learning. With the development of science and technology, talents face higher and higher requirements from the world. In order to improve competitiveness, China vigorously advocates liberating students' thoughts and developing their creativity in the basic education stage, thus IT teaching should have the ability of transforming students from passive users into creators of IT applications.

The teaching goal of the school information technology curriculum reveals the general orientation of information technology education and is inseparable from the purpose and task of the general basic education in the country. The purpose of education is the overall requirement for the quality specifications of the educated and is the starting point and ultimate destination of all educators. In a sense, all educational purposes must be achieved through teaching as an intermediary, so teaching itself can be understood as a means to enable students to achieve educational goals. Therefore, how to translate education goals into teaching goals and then use them to guide the implementation of teaching is an important issue for the teaching staff. Due to the cross-disciplinary characteristics of STEM, it can greatly help achieve teaching goals.

3. Implications of STEM Education for School Information Technology Education

STEM is characterized by solving problems in life situation with multidisciplinary knowledge and designing products, which creatively coincides with the ideas of cultivating experience and creative thinking in IT education. Therefore, we can use STEM's ideas to guide school IT teaching which finds out problems in the life situation. Then we analyze them by integrating knowledge of each subject to solve these problems, and finally produce products.

3.1. Setting Situation and Identifying Problems

The main tasks of the school information technology curriculum are to cultivate students' interest and awareness in information technology, enable students to understand and master the basic knowledge and skills of information technology, and understand the profound impact of the development and application of information technology on human daily life and science and technology. Through information technology courses, students have the ability to obtain information, transmit information, process information and apply information. Teachers should educate students to correctly understand cultural, ethical and social issues related to information technology, and use information technology responsibly. Information literacy implies using information technology as a means to support lifelong learning and cooperative learning, laying the necessary foundation for adapting to the learning, work, and life of the information society.

The goal of school education is to prepare students for future study and develop their interest in learning. In the aspect of IT education, the aim is to equip students with basic computer knowledge and skills and to stimulate their interests in IT. IT teachers should not only impart knowledge to students, but lead students to discover, analyze and solve problems in situations set up by teachers.

We emphasize the importance of learning to design in complex and meaningful problem

situations. Students are supposed to cooperate while solving problems that are embedded in real situations or problems related to the real world, which will definitely promote students' understanding and constructing of what they have learned. The scientific knowledge behind the problem forms the skills to solve problems and the ability to learn independently. It can promote the development of students' cognitive abilities by experiencing the process of acquiring knowledge. Students will have a thorough understanding of the knowledge and be able to apply the knowledge acquired to solve real world problems. Moreover, the knowledge acquired can also be applied to social and contextual transfer of knowledge. The teaching helps to develop students' thinking and analytical ability and enable them to better retain what they have learned.

The setting of situation and problems ought to meet three requirements. First of all, the situation should be related to students' life from which students can find some direct experience that helps them to understand the situation; Secondly, the situation and the problems should be interesting that may arouse the students' curiosity and thirst for knowledge, attracting them to conduct further researches; thirdly, the situation and the problems should be scientific, relevant to the knowledge that the students are familiar with, not be anything that is made up arbitrarily, which will lead the teaching to a wrong direction. In short, the situation should be life-related, interesting, and scientific so that the students can acquire not only knowledge, but also the ability to use the knowledge in certain situations, in the society, and later transfer the knowledge to relevant situations in the process of solving problems.

3.2. Integrating Information and Analyzing Problems

Students need to analyze problems they find under the guidance of their teachers by integrating information from various aspects. Anything in life cannot be fully explained by a single subject. Likewise, the life situation we created in teaching involves lots of knowledge coming from life. The knowledge can be categorized according to subjects, which will facilitate scientific research, in-depth exploration of the mysteries of natural phenomenon. Division of the knowledge into parts will make it easier to teach. Nevertheless, it does not reflect the real and interesting world. Therefore, we cannot use only one subject knowledge to analyze problems. Other subjects must be taken into consideration. For example, when we use PowerPoint to make presentations, we need to use aesthetics and psychology to design pictures, text composition, and theme colors; we need to use communication theories to design animations; we need to use mathematics to design diagrams. Students know little about the information integration. Most of the time, they use their talent and intuition to organize the information. Teachers can extract important contents for students to refer to. With these integrated information, the analysis of the problems becomes much easier.

The new curriculum reform also requires transforming from teacher-centered to students-oriented teaching method and turning students from passive knowledge recipients into active explorers, giving full play to the subjectivity of students. Teamwork is likely to get a more comprehensive viewpoint of the same question than solving the problem by oneself. Furthermore, the course is limited in terms of time and usually the questions cannot be completed by one student alone, thus teamwork is needed. When their analysis reaches certain degree, they will understand how to solve the problem and the responsibility for each team member will be determined accordingly. On the one hand, students may influence each other through collaborative learning; on the other hand, students can learn to cooperate and share.

The learner-oriented integration model adopts a project-based approach. Students complete and submit tasks individually or in groups. They need to apply their interdisciplinary knowledge while finishing the assignments. They are supposed to focus on the learning content as well as interdisciplinary knowledge. While the students are engaged in the process of solving project problems, teachers adopt the new role of being a timer, guide, facilitator, coordinator, inspector, supervisor, and evaluator.

The learner-centered integration model emphasizes creating a rich educational environment in which instructor can actively intervene, research and facilitate, allowing students to interact, explore and discover in an environment rich in STEM knowledge so that they can create meaning and

acquire knowledge in a constructive environment. Thus, it is crucial to look for integrated points in the course design so that STEM knowledge can be carefully embedded in the course.

3.3. Practical Operation and Problem-solving

When the problems are identified and designated, it is time to solve these problems. Experience is very important in the process of solving problems, especially for school students whose logical ability is still limited to concrete objects and whose thinking focuses on the physical, observable, perceptible aspects of the objects. They are lack of abstract thinking. Information technology is a highly operational discipline mainly relying on software to edit resources and create new things. The software is user-friendly with its revocable interface which offers students rich experience in the process of solving problems. First of all, works produced by the software have high visibility; secondly, when users are dissatisfied with parts of their work or something goes wrong, they are able to cancel or recover their works on the basis of the previous works; thirdly, due to the high-speed operation of the computer, these steps can be implemented almost in seconds.

Students can not only acquire knowledge about the results of the problems they are solving, but also about the process of solving the problems itself. They participate in and experience the process, which will have a profound impact on their long-term development in both work and life.

The purpose of solving the problem is to grasp the knowledge contained in the problem or to support problem solving process. The problem is the intersection and integrated point of multidisciplinary knowledge fusion. It is the trigger that promotes students' learning and inquiry, and is the carrier of innovative learning.

3.4. Design and Creation and Transfer Application

Students' interest may be stimulated greatly in such teaching that requires them to use and integrate information about many subjects and complete their works with their hands and brains. If the teacher sticks to this teaching method and keeps inducing and guiding students with their works, the students' learning interest will be stabilized and promoted, which will bring about positive results. They will be exempted from interference of negative material interest and spiritual interest and gradually expand their interest in learning, promote the deepening and developing of creative thinking on the basis of mastering existing subject knowledge. Meanwhile, the knowledge acquired from life scene is stable and flexible, easy to be applied to different life situations.

Most of the learning outcomes of information technology are presented in the form of works, such as the character beautification in Word, the theme paintings in Painting, the algorithms in Programming, etc. In the process of producing these works, knowledge fusion and transfer will be promoted, the learning outcomes will be externalized and the knowledge acquired and the ability mastered will be apparent. Designing creative works is an indispensable way to obtain a sense of achievement, and an important way to maintain and motivate learning motivation and keep learning curiosity.

4. Applying STEM Education to School IT Education

4.1. Renewing Teaching Contents

Despite the rapid development of information technology, there are big discrepancies in different regions, thus schools in different regions tend to use different textbooks. Most of the schools refer to and draw highlights from the Standard for Basic Education Information Technology (2012) formulated by the Information Technology Education Committee of the Chinese Association for Educational Technology. Nowadays, new technologies are invented day by day, which have changed our lives to a great extent. As a course closely related to technologies and a course cultivating students' information literacy, the teaching contents of information technology require appropriate renewal in order to strengthen links with other subjects.

4.2. Integrating Resources

The learning outcomes of information technology are the works. In the process of producing

works, we need to integrate all aspects of resources. For example, we have to use the Internet to search data, to shoot on the spot, even to interview someone when we are about to display local customs; we need to provide students with access to all kinds of resources, and at the same time, to make full use of resources such as cooperating with universities to guide students with their study, to visit the Science and Technology Museum, to participate in the exhibitions so as to create a good learning environment.

4.3. Strengthening Cooperation among Teachers

Teachers used to dive into the knowledge system of a certain subject, and rarely undertake interdisciplinary interaction. Cross-disciplinary communication and cooperation is the core idea of STEM education. The implementation of the information technology teaching under the guidance of STEM has put forward higher requirements for teachers, requiring teachers to improve their interdisciplinary abilities, to cooperate with teachers of various subjects, to be aware of the interdisciplinary knowledge, aids, ways and methods that are necessary for students, to pay more attention to the way students learn, and to support or help students better analyze and solve problems.

5. Conclusion

This paper studies the characteristics of STEM education and proposes to apply the ideas of cross-discipline and integrating resources before designing teaching materials for school information technology education. Based on the analysis of STEM-based school IT education, we suggest teachers to renew teaching contents, integrate various resources, and strengthen cooperation among teachers in order to improve students' practical abilities and implementing abilities, stimulate their innovative thinking and technical application ability, which can achieve better teaching performance than before.

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