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Research on the Teaching Mode of Junior High School Information Technology Course Based on Computational Thinking Cultivation

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Abstract: This article analyzes the problems in information technology teaching in county-level junior high schools in Yunnan Province, and clarifies the goals, requirements, and guidance of the new curriculum standards. Combined with constructivism, humanism, and cognitive learning theories, the guidance of information technology teaching is enhanced. Based on the construction of problem driven teaching mode, task driven teaching mode, and project-based teaching mode, combined with field investigations, a PTP teaching mode suitable for information technology teaching in county-level junior high schools in Yunnan Province was constructed. The PTP teaching mode is mainly divided into three parts: preparation stage, implementation stage, and summary stage to carry out teaching, aiming to cultivate students' computational thinking in the implementation process of teaching. The new teaching model constructed in this study aims to provide some reference for county-level junior high school information technology teachers to teach courses related to the cultivation of computational thinking.

1. Introduction

In today's rapidly developing information society, we must learn to learn efficiently, master advanced scientific methods of computational thinking, and continuously improve our problem-solving abilities and skills.

The *Compulsory Education Information Science and Technology Curriculum Standards* issued by the Ministry of Education in 2022 explicitly classify computational thinking as one of the four core competencies of the information technology discipline. Teachers are required to pay more attention to cultivating students' computational thinking while teaching basic information technology knowledge [1]. However, the curriculum structure of information technology courses in some remote county-level junior high schools in Yunnan Province is relatively outdated, with a focus on basic knowledge and a lack of introduction to cutting-edge technologies and practical skills, making it difficult to stimulate students' interest in learning and improve their practical skills. In addition, the traditional teaching method is mainly based on teacher led instruction. Students have limited opportunities for practical operation and lack project-based and application-oriented teaching, making it difficult to cultivate their innovative thinking and problem-solving abilities. How to integrate computational thinking into the teaching process of information technology courses in county-level junior high schools, allowing students to experience the use of computational thinking to analyze problems and solve them in the classroom, and promoting students to transfer computational thinking in the context of daily learning and life problems has become the focus of this study.

2. The Concept of Computational Thinking

In 2006, Professor Zhou Yizhen published an academic article titled *Computational Thinking* in the authoritative American computer journal Communications of the ACM, which first proposed the concept of "Computational Thinking" and gained recognition from many experts and scholars. She believes that computational thinking refers to the cognitive activity of using knowledge related to computer science to solve problems and systematically design and understand a series of human behaviors [2]. Professor Zhou Yizhen further elaborated on computation in 2011, stating that computational thinking is the process of people thinking when analyzing problems, proposing solutions, and solving problems. The Computational Thinking (AGuide for Teachers) published by CAS (Computing At School) organization believes that computational thinking is the process of identifying computation and using computational tools and techniques to understand artificial and natural information systems. It mainly includes algorithmic thinking ability, logical thinking ability, recursive thinking ability, abstract thinking ability, and evaluative thinking ability [3]. ISTE and CSTA, two educational associations, have defined computational thinking as a process of problem-solving, which includes six basic elements: problem definition, data integration, algorithm implementation, presentation, solution evaluation, and transfer [4]. In the new curriculum standards, computational thinking is defined as the abstract, decomposition, modeling, algorithm design, and other thinking activities involved in the application of computer science thinking methods by individuals in the process of solving problems [5].

Based on the comprehensive definition of computational thinking by scholars and organizations mentioned above, and after consulting a large number of literature related to computational thinking, this study has provided a new definition of the concept of computational thinking. This study believed that computational thinking is a way of thinking that emphasizes the use of computer science principles and methods to solve and think about problems, mainly including six aspects: problem decomposition, abstraction, logical reasoning, algorithm design, summarization, and evaluation.

3. The Relationship between Computational Thinking and Junior High School Information Technology Curriculum Teaching

In information technology courses, computational thinking can be integrated as a skill throughout the entire teaching process to enhance students' learning outcomes and skill development.

(1) Information technology courses are an effective way to cultivate students' computing and thinking abilities

(2) The information technology course provides students with a practical platform for applying computational thinking

(3) Information technology courses can serve as a medium for teaching computational thinking

(4) Information technology is an important tool for supporting and implementing computational thinking

Therefore, Computational thinking provides guidance and framework for students' learning and application in the field of information technology. The combination of these two can provide students with comprehensive computing skills and cultivate their problem-solving abilities in daily life and career development.

4. Problems in the Teaching of Information Technology Courses in County-Level Junior High Schools

(1) The teaching content is monotonous and lacks systematic structure

The information technology classroom teaching content in remote county-level junior high schools in Yunnan Province is usually relatively basic, involving simple computer operations (such as mouse and keyboard usage, file management) and the use of basic office software (such as Word, Excel). Although these contents are important, they are often too monotonous and fragmented, lacking systematicity. After learning an isolated skill, students are unable to integrate it and solve more complex problems.

Currently, based on actual performance, students find it difficult to integrate multiple knowledge points to solve problems when faced with comprehensive tasks. Students lack understanding of the connections between knowledge points and have a rigid way of thinking. When facing complex problems, students often fail to effectively decompose them, and their thinking is limited to specific operations rather than logical solutions.

The gap with the cultivation of computational thinking is mainly reflected in the scattered and unsystematic content of information technology teaching in county-level junior high schools, which makes it difficult for students to connect different knowledge points and increase the difficulty of using this knowledge to solve complex problems. Students lack a clear learning path and find it difficult to gradually deepen their learning content. The teaching content is not modular, and students cannot practice breaking down problems into smaller parts.

(2) Traditional teaching methods, lack of interaction and practice

The teaching method of information technology in remote county-level junior high schools in Yunnan Province is relatively traditional, usually using lecture style teaching, where the teacher lectures first and the students memorize later. There are fewer practical and interactive activities. Students rarely have the opportunity to hands-on, let alone participate in challenging projects.

Currently, based on their actual performance, students lack sufficient practical experience and have limited abilities in programming and solving technical problems. Due to the lack of project driven learning opportunities, students have weak innovation awareness and abilities, making it difficult for them to propose and implement new solutions. When facing new and complex problems, students lack experience in strategic thinking and exploration.

The gap with the cultivation of computational thinking is mainly reflected in the lack of practical opportunities for students to understand and apply computational thinking through practical operations. Students are not involved in real projects and lack opportunities to apply their knowledge comprehensively, making it difficult to cultivate their ability to solve complex problems. The teaching process lacks teacher-student interaction and discussion among classmates, making it difficult for students to stimulate computational thinking through discussion and collaboration.

(3) Insufficient professional competence and lack of continuous training for teachers

Information technology teachers in remote county-level junior high schools in Yunnan Province may have deficiencies in professional knowledge and teaching skills. On the one hand, some teachers may not have a background in information technology, and on the other hand, teachers lack continuous professional training and development opportunities during their tenure, resulting in relatively outdated knowledge and teaching methods.

At present, based on actual performance, teachers find it difficult to provide in-depth and high-level teaching. Their teaching content is relatively superficial, and there is insufficient guidance for solving complex problems. Due to the lack of attractiveness and innovation in teaching, students have low interest and lack the motivation to learn. Due to the lack of continuous professional development, new teaching techniques and methods are difficult for teachers to introduce, and the course content and format remain outdated.

The gap with the cultivation of computational thinking is mainly reflected in limited professional knowledge, inadequate teacher professional background, and insufficient knowledge reserves. Complex computational thinking concepts are difficult to explain in depth. The teaching method is single and lacks diverse and innovative teaching strategies, which cannot effectively stimulate students' computational thinking. There are few training opportunities, and teachers lack continuous training and professional development opportunities, making it difficult for them to keep up with the times.

5. Construction of Information Technology Teaching Mode for Junior High School to Cultivate Computational Thinking

This study is based on the investigation of the teaching situation of information technology courses in remote county-level junior high schools in Yunnan Provinc, through literature research, guided by constructivist learning theory, humanistic learning theory, and cognitive learning theory, and combined with the basic elements of computational thinking and the information technology curriculum standards of compulsory education, investigates the general process of Problem driven teaching model, Task driven teaching model, and Project model. Buildig a PTP teaching model suitable for information technology curriculum teaching in remote county-level junior high schools in Yunnan Province based on problem driven, task driven, and project-based approaches. The PTP teaching mode is mainly divided into three major stages: preparation stage, implementation stage, and summary stage, as shown in Figure 1.

Figure 1: PTP Teaching Mode Diagram

6. Implementation of PTP Teaching Mode

6.1. Preparation Stage

The preparation stage corresponds to the teacher's lesson preparation stage, which requires the teacher to carefully study the textbook, grasp the key and difficult points, have a comprehensive understanding of the students' personality traits and learning foundation, choose teaching content reasonably, clarify teaching objectives, follow the requirements of the curriculum standards, clarify teaching tasks [6], choose appropriate teaching methods, and design a teaching plan that is easy for students to accept.

6.2. Implementation Phase

6.2.1. The Central Process of Teaching Implementation

(1) Select question

Teachers teach according to the requirements of the *Information Technology* course, using existing teaching resources and methods combined with students' interests, and combining life phenomena and hot events to create situational problems. The teaching content is hidden behind the problems, guiding students to actively discover problems and avoid passive acceptance.

(2) Analyze the problem

Teachers guide students to use computational thinking to analyze the essence of problems based on the problems they discover, and clarify which problems need to be focused on and which ones are secondary. The teacher further abstracts the problems that need to be solved, breaks down complex problems into several simple questions for analysis, and helps students analyze which problems they can solve using existing knowledge and which problems require learning new knowledge to solve, thus cultivating students' decomposition thinking.

(3) Develop a plan

This stage aims to provide students with opportunities for independent knowledge construction, allowing them to have their own ideas and plans to form possible solutions. Teachers play an auxiliary role in providing suggestions and evaluating the feasibility of students' plans and models. At the same time, special attention should be paid to the abstraction of students' computational thinking and the application and cultivation of algorithm awareness, providing students with sufficient learning resources, comparing the advantages and disadvantages of different algorithms, allowing students to personally experience the process of using computational thinking, and understand the methods of using computational thinking to formulate problem-solving ideas.

(4) Execution plan

In the process of students solving problems, emphasis should be placed on cultivating their sense of cooperation, hands-on ability, and encouraging them to sort out problems. Before starting to solve problems, students should have a clear understanding of the essence and requirements of the problem, so that they can come with targeted and prepared solutions to improve problem-solving efficiency.

(5) Achievement display

After solving the problem, let students use the information technology they have mastered to showcase their learning outcomes, share their ideas, and introduce how they analyze the problem, develop solutions, and solve the problem. What problems were encountered during the process? How was it resolved? This section mainly focuses on cultivating students' ability to generalize thinking in computational thinking, as well as their language organization and expression skills.

(6) Student self-evaluation and peer evaluation

After the achievement display is completed, the teacher organizes students to evaluate and assess others. Through communication and evaluation, students can understand their strengths and weaknesses, continuously improve their thinking and methods, and promote the development of their summarizing ability.

6.2.2. Teacher Activities should be Combined with the Characteristics of Information Technology Courses

(1) Teachers should create scenarios that reflect the comprehensiveness of information technology courses

When creating problem scenarios, teachers can reflect the comprehensiveness of the course content, ensuring that students can comprehensively apply various aspects of knowledge they have learned. Teachers can introduce practical cases, combine course content with actual application scenarios, integrate multiple course contents into a comprehensive project or task, and require students to comprehensively apply the knowledge and skills learned in various aspects. Teachers should make appropriate adjustments based on the course objectives and students' ability levels, ensuring that problem scenarios can comprehensively reflect the course content, promote students' comprehensive development, and cultivate their comprehensive application abilities.

(2) Guiding students to analyze problems should reflect the foundational nature of information technology courses

When guiding students to analyze problems, teachers should emphasize the basic theory of information technology courses to ensure that students understand and can apply the fundamental knowledge of information technology to analyze problems. Teachers can provide cases and examples to help students connect basic knowledge with practical problems. By analyzing these cases and examples, students can apply their basic knowledge to solve similar problems. Teachers can reflect the foundation of the curriculum when guiding students to analyze problems, help students apply the basic knowledge and concepts they have learned to analyze problems, and gradually cultivate their ability to analyze, think, and solve problems.

(3) When organizing students to independently explore and develop solutions, it is necessary to reflect the practical, creative, and developmental nature of information technology courses

Teachers provide guidance and support to students in the process of independent exploration and developing solutions, helping them overcome problems and difficulties, and encouraging them to develop and practice innovative solutions. Teachers can provide necessary tools to assist students in independent exploration and practice, including computer equipment, software applications, experimental equipment, etc. Meanwhile, teachers can also guide students to explore and utilize other available resources, expanding their solutions. Teachers demonstrate the practicality, creativity, and developmental nature of information technology courses in organizing students to explore and develop solutions independently. This helps students apply what they have learned, actively participate in practice and innovation, and cultivate their ability to solve problems and think creatively.

(4) When assisting students in solving problems, it is important to demonstrate the instrumental nature of information technology courses

When teachers assist students in solving problems, they should guide students to independently choose suitable information technology tools based on the nature of the problem and their level of ability, taking into account the needs of the problem and their own proficiency. Teachers can also support students' difficulties and challenges in using tools through Q&A, discussion, and guidance. Teachers should demonstrate the instrumental nature of information technology courses in assisting students in problem-solving. Teacher guidance and support can help students make reasonable choices and use information technology tools, and improve the quality of their problem-solving skills. At the same time, students can also better understand the functions and potential of information technology tools and apply them.

(5) While organizing student achievement presentations, it is important to reflect the developmental nature of information technology courses

During the process of sharing student achievements, teachers can guide students to evaluate themselves. Students can reflect and share their growth and development in information technology courses, as well as the challenges and difficulties they face when using information technology courses to solve problems. This helps students recognize their progress and development, promote their self-awareness and learning motivation. After students share their achievements, teachers can guide them to think and plan for further development. Teachers can provide learning resources, project opportunities, or practical advice to help students further expand and deepen their learning outcomes, and set goals for future learning and development.

(6) In the process of organizing students' self-evaluation and peer evaluation, the developmental nature of information technology courses should be reflected

Teachers encourage students to self evaluate their learning process and assess their academic performance. Students can evaluate their performance and growth in various aspects based on evaluation criteria. Teachers can provide guidance questions to help students evaluate themselves and record their observations and findings. Teachers should also organize students to evaluate each other's learning outcomes and abilities. Students can provide feedback and suggestions to each other, pointing out each other's strengths and directions for improvement. This is helpful for students to develop their critical thinking skills and obtain new perspectives and solutions from feedback from others.

6.2.3. Student Activities should Reflect the Application of Computational Thinking

(1) Using decomposition thinking to clarify the target problem

When decomposing problems, students can divide them into different levels. Higher-level problems can be further decomposed into lower-level sub-problems, forming a hierarchical structure. This helps students organize their thinking and gradually break down complex problems. Students should also pay attention to the relationships and dependencies between sub-problems. Some sub-problems may depend on the solutions or outcomes of other sub-problems. By using computational thinking to decompose ideas, students can break down complex problems into more specific sub-problems, thereby better understanding the structure and relevance of the problem and focusing on solving the main problem. This method helps students to think more systematically and effectively when solving problems, improving and enhancing their thinking integration.

(2) Using decomposition thinking and abstract thinking for collaborative exploration and analysis

After identifying the main problem, it can be broken down into smaller components or sub-problems through group collaboration. Students can think about different aspects of the problem and break it down into more specific and manageable parts. Key elements and essence are extracted from specific contexts, and patterns within them are explored. By using decomposition thinking to analyze problems, students can gain a deeper understanding of the structure and components of the problem and identify the patterns and characteristics of the problem from them. This method can help students think more clearly, identify key points of problems, and cultivate their analytical skills and creative thinking, thus better solving complex problems.

(3) Using decomposition thinking, abstract thinking, and algorithmic thinking to develop plans and clarify division of labor

Students should first have a comprehensive understanding of the requirements and limitations of the problem. They need to understand the background, goals, and specific aspects that need to be addressed to solve the problem. The problem can be broken down into smaller sub-problems or tasks, and students can think about different aspects of the problem and determine the specific steps or modules required to solve it. Key concepts and patterns are extracted from specific contexts, and problems can be abstracted into more general forms. This helps students establish a universal model or algorithm for the problem. Students can design algorithms to solve the problem based on the results of decomposition and abstraction and clarify the steps and logic of the algorithm. By utilizing the decomposition thinking, abstract thinking, and algorithmic thinking to develop solutions to the problem, students can break down a complex problem into manageable pieces and establish abstract models and algorithms for problem-solving. This method can help students cultivate systematic and creative thinking in problem-solving while enhancing their computational thinking and algorithm design abilities.

(4) Using algorithmic thinking to solve problems

When solving problems, students need to choose and design corresponding algorithms to solve them. They can use flowcharts, pseudocode, or programming languages to describe the steps and logic of algorithms. By applying the algorithmic thinking to solve problems, students can systematically analyze and solve complex problems. The algorithmic thinking cultivates students' logical thinking ability, problem-solving ability, and creative thinking, enabling them to apply universal problem-solving strategies to deal with various problems. This method is not only useful in the fields of computer science and programming, but also applicable to problems that arise in other disciplines and real life.

(5) Using generalization thinking and evaluative thinking to showcase and share achievements

Application of the generalization thinking: the first step is to identify the key points. Students should identify the most important and valuable key points from their achievements. These key points should be able to effectively convey their work and results. Next is integrating information. Students need to integrate information from various parts, combining different perspectives, discoveries, or solutions together to form a complete summary. Finally, the redundancy should be removed. Students should eliminate unnecessary details or repetitive information to make the summary more concise, clear, and highlight the core content.

Application of the evaluative thinking: firstly, the accuracy should be evaluated. Students need to evaluate the accuracy and reliability of their results. They should consider the rationality of the data, methods, and reasoning they use, and conduct appropriate validation and verification. Next is to analyze the advantages and disadvantages. Students should analyze the strengths and limitations of their results, and they can consider the potential impact, application areas, and possibilities for improvement of the results. Finally, suggestions are provided. Students can provide targeted suggestions and improvement measures based on their evaluation of the results. These suggestions should be based on a deep understanding of the problem and a comprehensive evaluation of the solution.

By utilizing the generalization thinking and evaluative thinking to present and share results, students are able to convey their work and achievements in a concise and clear manner while conducting in-depth evaluation and analysis. This helps improve students' communication skills, logical thinking, and self-evaluation abilities while also enabling them to better share and communicate their achievements with others.

(6) Using self-evaluation and peer-evaluation to train students' generalization thinking and evaluative thinking

Firstly, the self-evaluation is the process by which students evaluate their learning outcomes, progress, and performance. When conducting self-evaluation, students need to use generalization thinking to summarize and generalize their learning experiences, knowledge, and skills. Secondly, the peer-evaluation is the process of students evaluating and providing feedback to each other. By participating in the peer-evaluation, students can evaluate their learning outcomes not only from their own perspective, but also from the perspectives of other classmates. When conducting peer-evaluations, students need to apply the evaluative thinking, which means being able to objectively observe, analyze, and evaluate the work of others. Through self-evaluation and peer evaluation, students can improve their ability to generalize and evaluate, thereby gaining a better understanding of their learning outcomes and improving their learning methods.

(7) Summary Stage

The summary stage corresponds to teaching evaluation, where teachers conduct self-evaluation and peer-evaluation based on showcasing students' achievements. The achievements of students and the teaching of teachers are objectively evaluated as a whole. The optimal solution is summarized, and the application of computational thinking in the problem-solving process is emphasized. Students should be guided to reflect, actively recognize and value computational thinking, and cultivate their own computational thinking abilities. Students should also be encouraged to use the computational thinking to solve problems and think critically. This solution can be applied to other disciplines and to solve problems encountered in daily life. After the completion of teaching, the goal is to cultivate students' algorithmic thinking, logical thinking, abstract thinking, creative thinking, computer thinking, and improve their problem-solving abilities.

7. PTP Teaching Mode to Cultivate the Computational Thinking of County-level Middle School Students

7.1. Creating Real-life Problem Scenarios to Stimulate students' Computational Thinking

In the PTP teaching mode, the cultivation of students' computational thinking is mainly reflected in the implementation stage, where teachers follow the teaching content and objectives of the information technology course. By combining existing teaching resources and methods with students' interests and incorporating real-life phenomena and hot events to create real-life problem scenarios, students' senses can be stimulated, and they can be encouraged to actively engage in the scenarios created by the teacher, thereby stimulating their computational thinking.

7.2. Incorporating Decomposition Thinking into the Process of Students' Analyzing Problems

Teachers can guide students to use the decomposition thinking of computational thinking to analyze the essence of problems based on the problems they discover. Then the complex problem can be broken down into several simple problems, allowing students to clarify the main problems and the secondary problems.

7.3. Cultivating Students' Abstract Thinking and Algorithmic Thinking in the Process of Formulating the Plan

With the guidance of teachers, students are encouraged to develop unique solutions based on their own ideas and plans, and then teachers provide suggestions and feasibility evaluations for students' plans and models. This can provide students with sufficient learning resources to compare the advantages and disadvantages of different algorithms, allowing them to personally experience the application of abstract thinking and algorithmic thinking and understand how to use the abstract thinking and algorithmic thinking to develop solutions to problems.

7.4. Training Logical Thinking in the Process of Problem-solving

Student group cooperation is encouraged in the process of solving problems. Students are encouraged to use the computational thinking to organize the logic of the problem before starting to solve it. Having a clear understanding of the essence and requirements of the problems can enable students to solve problems with goals and preparation while improving problem-solving efficiency and exercising their logical thinking.

7.5. Understanding Computational Thinking during the Results Presentation and Evaluation Phase

Students are encouraged to use their mastery of information technology to showcase their learning outcomes, share their ideas, and introduce how they analyze problems, develop solutions, and solve them. This process focuses on cultivating students' ability of generalization thinking. In the evaluation stage, teachers propose the concept of computational thinking based on students' systematic understanding of their problem-solving process, allowing students to experience computational thinking in practice and understand computational thinking through reflection.

8. Conclusion

The main purpose of this study is to develop an information technology teaching model (PTP) for cultivating computational thinking among county-level junior high school students, which combines the cultivation of computational thinking with learning knowledge, enabling students to systematically and scientifically master computational thinking methods while learning information technology knowledge. Students can experience computational thinking while exploring information technology courses and are able to consciously transfer computational thinking to daily learning and life for application.

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