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A Study of Smart Classroom Teaching Model of ADDIE Model under Digital Transformation

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Abstract: *Under the background of digital transformation, the smart classroom is a product of the rapid development of education digitalization and then become a research hot spot. Nowadays, the existing model research is short of realistic guidance and operational basis for the application of in-depth integration of smart education classroom disciplines, affecting the classroom teaching effect to some extent. Therefore, in order to provide reference for scholars and pedagogical methods for middle school teachers, the intrinsic coupling, principles, and design process of smart classroom instructional design under the model are proposed, combining the classic instructional design model, ADDIE model, with the smart classroom teaching model. The lesson "Automatic Obstacle Avoidance Robot" is used as an example to assist the illustration.*

Keywords: *digital transformation; ADDIE model; smart classroom; teaching model*

1. Introduction

In the context of digital transformation, the rapid development and application of new digital technologies such as artificial intelligence, the Internet, big data, virtual technology and other new digital technologies in education and teaching, has promoted the transformation of China's traditional classroom environment in the direction of digitalization. The proposed concept of "smart classrooms" aims to innovate and transform traditional classroom teaching. Currently, there has been extensive research and discussion on smart classrooms worldwide regarding teaching environments, classroom evaluation, and teaching models. However, the lack of existing research on the integration of wisdom classroom subject teaching with the reality of guidance and operational basis has resulted in low application enthusiasm among teachers during the implementation process. This has led to arbitrary changes in the teaching process and ineffective implementation of reality, among other dilemmas [1]. Teachers encounter challenges while implementing the smart classroom teaching mode, primarily due to a lack of understanding of the model and the absence of design and implementation standards as a reference. As a result, teachers tend to use the teaching mode poorly.

On the basis of the concept of a smart classroom, this article fully analyzes the structure of the ADDIE model. This article proposes a teaching model that integrates the ADDIE model and smart classrooms' features. The model is exemplified using the "Automatic Obstacle Avoidance Robot" course to design teaching links. The goal is to offer practical guidance and model support to teachers to carry out effective smart classroom teaching.

2. The intrinsic coupling of the ADDIE model and the smart classroom

2.1. Core concepts of the ADDIE model

The ADDIE model is a well-known instructional design model based on the constructionist model, which focuses on "learning" and embodies a series of processes of "what to learn", "how to learn" and "how effective is the learning" [2]. The ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation, which is represented as a cyclical model as shown in Figure 1.

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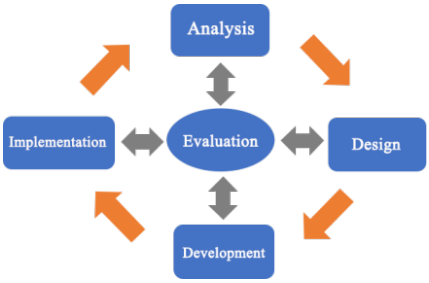

Figure 1: The ADDIE teaching model.

2.2. Core concepts of the smart classroom

A smart classroom is the inevitable product of the combination of technology and education. They focus on both the teacher's "teaching" and the student's "learning" processes, which is the core of smart education[3]. Smart classrooms utilize big data, artificial intelligence, and "cloud-desk-end" technology to create an intelligent digital learning environment that effectively integrates new technologies with classroom teaching. To create a digital, personalized and interactive learning environment that fosters creative thinking and improves analytical and problem-solving skills, it is essential to incorporate features such as data-based classroom analysis, diversified evaluation feedback, three-dimensional communication and interaction, and intelligent resource delivery. By doing so, learners can benefit from a more effective and engaging educational experience[4].

2.3. Analysis of the intrinsic coupling between the ADDIE model and the smart classroom

The smart classroom teaching model aims to create a digital, intelligent, and personalized learning environment through the use of artificial intelligence, big data, cloud computing, and other information technologies. This concept falls under the umbrella of smart education and helps to cultivate the core literacy of learners [2]. The widely accepted model for smart classroom teaching consists of five fundamental elements, which are the constructionist learning model, the establishment and achievement of smart objectives, support for mobile internet technology, comprehensive course teaching, and diversified teaching evaluation [5].

Structurally, the five elements of the smart classroom teaching model and the five processes of the ADDIE model are closely connected and integrated. The ADDIE model is guided by the constructionist model, which is a useful tool for intelligent goal-setting and realization. Mobile Internet technology can provide technical support for teaching the ADDIE model. The entire teaching process, from preparation to implementation to evaluation, follows the ADDIE model. The diverse teaching evaluation methods are consistent with the formative and conclusive evaluations of the ADDIE model.

Conceptually, a smart classroom is an intelligent environment that integrates data, resources, and activities to support personalized learning and improve students' literacy and development. Compared with the traditional classroom, the smart classroom is more responsive to the requirements of quality education [6]. The ADDIE model is a systematic instructional design approach that focuses on student-centered learning. It aims to enhance students' problem-solving and creative thinking abilities, and fosters the development of students' wisdom, thinking skills, and values. The model is consistent with the principles of quality education and has a positive impact on students' future development.

In the current era of digital transformation, with the rapid advancements in cloud computing, big data, artificial intelligence, and other cutting-edge technologies, the integration of the ADDIE model into smart classroom teaching can significantly enhance the effectiveness of education. By leveraging information technology, the ADDIE model can help personalize and empower students' learning, while also promoting the accuracy and efficiency of teachers' teaching. Ultimately, this can lead to a significant improvement in the overall quality of education.

3. Model construction of intelligent classroom teaching design

3.1. Design principles

The ADDIE model follows a systematic problem-solving approach through its stages [7]. As a result,

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the first principle of instructional design is systemic. This means that in the process of designing instruction, we need to consider all the elements involved such as teaching activities, learners, content, environment, methodology, objectives and feedback. It is important to carefully integrate these elements and their respective relationships scientifically and reasonably to achieve the best possible teaching outcomes.

The creation of smart classrooms is the outcome of the seamless integration of education and technology in the modern era [8]. Therefore, the second principle of smart classroom teaching design is to ensure the effective integration of information technology and subject teaching. In the context of digital transformation, it is crucial to utilize information technology to the fullest extent possible, optimize subject teaching methods, and maximize the role of technology in the teaching process. Building an intelligent and digital smart classroom teaching environment is essential to achieve these goals.

3.2. Design presentation

The teaching and learning process in a smart classroom can be optimized by analyzing the intrinsic coupling between the ADDIE model and the design principles of the smart classroom. By fully integrating the advantages of the smart classroom and based on Professor Bangqi Liu's three stages of the smart classroom [9]. The teaching and learning process for the teacher's and student's activities can be further improved. This process includes the three stages of preview prerequisite, classroom interaction, and post-class consolidation as shown in Figure 2.

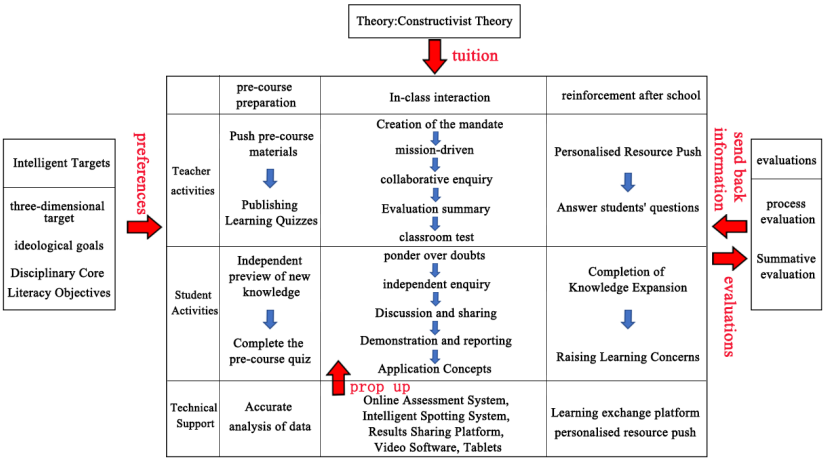

Figure 2: Smart classroom teaching model based on ADDIE model.

4. A Case Study of Intelligent Classroom Instructional Design

The ADDIE instructional model can be effectively integrated into smart classroom teaching design in a phased and hierarchical manner, allowing teachers to customize their teaching activities. This study uses the teaching design from the "Automatic Obstacle Avoidance Robot" section in Lesson 5 of the Cantonese version of Information Technology (Book III, Lower) as an example to analyze smart classroom teaching, based on the ADDIE instructional design model. The goal is to provide primary and secondary school scholars and teachers with references to carry out smart classroom teaching applications.

4.1. "Analysis" phase

The smart classroom teaching model requires an analysis stage that serves as a basis for subsequent design, development, implementation and evaluation of the teaching process. This stage involves analyzing teaching materials and learning conditions, using the "Automatic Obstacle Avoidance Robot" lesson as an example.

4.1.1. Analysis of teaching materials

Textbook analysis means that teachers need to clarify the book materials used and the learning topics explained in the lesson before the lesson and analyse the status and role of the lesson. In this study, the

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teaching design for lesson 5 of the fifth-grade "Information Technology" Cantonese version, which is titled "Automatic Obstacle Avoidance Robot" and included in the second half of the third book, is based on teaching aids that use sensors. The lesson combined the epidemic prevention demand brought by the COVID-19 epidemic, with the content that has been previously learned. The aim is to integrate them into a project theme lesson that guides students to use multiple channels to collect information, fully consider various situations, and carry out project design and logical judgment. It promotes group cooperation and cultivates innovative thinking and creativity by developing a non-contact intelligent disinfection device through project-based learning. This is the third lesson in the thematic project series, serving as a link to the next lesson and the heart of the thematic project curriculum.

4.1.2. Analysis of the learning situation

The analysis of the learning situation encompasses life experiences, prior knowledge, fundamental skills, and learning preferences. The objective of this lesson is to determine the appropriate grade level, identify which life experiences are relevant to the learning theme, assess the foundational knowledge and learning capabilities of the students before starting the lesson, and understand the common learning habits of most students in the class.

The target audience for this material is Grade 5 students who have experience working with common sensors such as infrared obstacle avoidance, light sensors, temperature sensors, etc. and have proficiency in using modules like "permanent loop" and "straight line". The students are highly enthusiastic about programming robots with hardware operation. They enjoy expressing themselves, demonstrating their skills, and are willing to take on challenges and practice. With the guidance of their teacher, they are able to complete tasks using sensors and building blocks.

4.2. "Design" phase

At the foundation of the smart classroom teaching mode lies the "design" stage. In this stage, teachers analyze teaching materials and learners' objectives purposefully and regularly to design smart course objectives. This process includes designing three-dimensional objectives, disciplinary core quality objectives, and Civics and Political Science objectives, totaling three parts of the content. For instance, let's consider designing teaching objectives for the Automatic Obstacle Avoidance Robot.

4.2.1. Three-dimensional objectives

Three-dimensional objectives have a guiding role in teaching and learning activities, which is a link between the preconceived ideas of teaching and learning outcomes and classroom practice, and guides teaching and learning to be carried out in an orderly and purposeful manner [10]. According to Bloom's classification of teaching objectives, they are divided into knowledge and skills, process and method, and affective attitudes and values.

In terms of knowledge and skills, students can master the "conditional judgment" module and write a program to enable intelligent spray disinfection for disinfection devices. Secondly, through the process and method, students can learn to use the "conditional judgment" module by watching animations, micro-course, and completing progressive tasks. They can also explore the problem-solving methodology by debugging programs to identify and analyze the root cause of any issues using their programming knowledge. Finally, in terms of affective attitudes and values, students can develop a sense of teamwork and cooperation by working in groups and programming a non-contact disinfecting device that sprays disinfectant. This activity not only serves to disinfect the environment but also allows students to experience the satisfaction that comes from using their knowledge to improve people's lives.

4.2.2. Disciplinary core literacy objectives

Every discipline has its own set of core literacy objectives that are unique to it. These objectives are formed based on the requirements of students' development of core literacy and are identified by analyzing the discipline's characteristics and whole-person literacy. The development points of the discipline are then determined according to a certain logical system. Different disciplines foster different features, and developing these in students is crucial for lifelong learning.

This study examines the core competencies of the IT discipline using "Automatic Obstacle Avoidance Robot" as an example, including information awareness, computational thinking, digital learning and innovation, and information social responsibility.

Watching a video of students disinfecting their hands at the school gate can help students learn how to acquire and process information in response to real-world problems. It also allows them to share

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information with their peers during group problem-solving activities, which can help them develop a better understanding of the value of information and gradually improve their information awareness. Moreover, while utilizing the "Conditional Judgement" programming module for the smart spraying function of disinfectant devices, students are encouraged to apply the principles of computer science in their problem-solving approach, thereby enhancing their computational thinking skills. During the teaching process, various digital resources and tools are utilized to ensure effective management of the learning process. These include the Learn Site learning platform and the flowchart programming platform, which help in creative problem-solving and foster the development of digital learning and innovation habits among students. Finally, teachers help students apply information technology to solve problems and enhance social responsibility by understanding and caring about information such as epidemics.

4.2.3. Civic and political objectives

In the new era, education has given rise to a new product - ideology and politics. It serves as a guide to enhance the quality of training and ideological and political education in colleges and universities. It addresses important practical issues such as "whom to train, what kind of people to train, and how to train them" [11]. Integration of moral and ideological education facilitates synergy between subject teaching and character-building, enabling the fundamental task of cultivating moral individuals. The lesson "Automatic Obstacle Avoidance Robot" uses sensor blocks as teaching aids to introduce students to the concept of obstacle avoidance. The lesson also incorporates the current need for epidemic prevention due to the COVID-19 epidemic, encouraging students to stay informed about major news events and develop a sense of patriotism and social responsibility.

4.3. "Development" phase

The development stage refers to the technical support provided for the smart classroom teaching mode. This support is designed to offer various technical conditions that facilitate teachers' teaching and students' learning throughout the entire teaching process. The use of new technologies empowers both the teachers and students, leading to the building of a digital, intelligent, and personalized smart classroom. The system is designed with several functions, including precise data analysis, an online assessment system, an intelligent point drawing system, a platform for sharing results, personalized resource recommendations, and a platform for learning and communication. For instance, in the context of the "Automatic Obstacle Avoidance Robot", refer to Table 1 for details.

4.3.1. Accurate analysis of data

To perform an accurate analysis of data, it is essential to collect, organize and evaluate the learning activities that students have completed before attending the class. The system uses various technologies such as big data, and cloud computing to statistically analyze students' pre-course preparation. The analysis includes the completion rate, the accuracy rate, and the error rate of homework, along with the average time spent by students on learning. Based on platform data, teachers can answer questions and personalize teaching in smart classrooms. Based on platform data, teachers can answer questions and personalize teaching in smart classrooms.

4.3.2. Online assessment system

An online assessment system is a teaching process where the teacher assigns tests, tasks, and other activities to students. After completing the assignments, the students upload them to the system. The system then uses technology to analyze the student's performance, such as the number of submissions, the correctness rate of assignments, and the word frequency diagram of the answers. This helps teachers to keep track of student's progress and ensure efficient learning. Teachers can use the platform to monitor student progress and make informed teaching decisions based on real-time feedback.

4.3.3. Intelligent point drawing system

During the teaching process, teachers often ask students to present reports or answer questions. To ensure fairness and randomness, they use intelligent sampling systems to randomly select students to answer questions or work in groups. These systems help ensure that every student has an equal chance to participate and contribute to the learning process. Not only can it improve students' vigilance and attention to learning, but it can also enhance teachers' efficiency in teaching.

4.3.4. Results-sharing platform

The results-sharing platform allows students to take photos and upload them to the class's learning platform using their tablets. Each student can access other people's portfolios or answers on the results-

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sharing platform, making it convenient for them to learn from each other and address any shortcomings they may have. Teachers can now comprehensively monitor students' work and results.

4.3.5. Personalised push of resources

Teachers provide students with various resources after class, based on their classroom performance and feedback from the platform data. These resources include teaching courseware, knowledge micro classes, practice question banks, knowledge expansion, and other relevant content. The objective is to help students fill gaps in their understanding as soon as possible, consolidate their knowledge, and achieve their learning goals. This link fully utilizes data visualization in smart classroom teaching, promoting personalized learning and teacher reflection.

4.3.6. Learning and exchange platform

On the learning exchange platform, students are allowed to freely express their thoughts and raise doubts related to the teaching materials, as long as they comply with legal and reasonable standards. Other students and teachers can view these doubts and provide answers, exchange ideas and progress together.

4.4. "Implementation" phase

The implementation stage is the focal point of the smart classroom teaching model, which is centered around students and supported by teachers. It involves analysis, design, and execution of the teaching activity. The teaching activities don't follow a fixed structure, allowing teachers to arrange lessons and learning based on the analysis of the materials and learners, with the aid of mobile internet technologies. Table 1 shows the three segments of Automatic Obstacle Avoidance Robot: pre-course study, in-class interaction, and post-class consolidation.

4.4.1. Pre-course study

In the pre-course preparation session, the teacher releases the pre-course preparation materials for assignments on the learning platform, including micro-classes on knowledge points, related articles, pre-course testing questions, and so on. Students complete the pre-course test questions after watching and recording each resource within the specified time. It is conducive for teachers to accurately analyse the data to grasp the students' pre-course preparation and make targeted teaching design.

4.4.2. In-class interaction

During the interactive part of the lesson, there is no fixed teaching process, but it is usually divided into five parts: creating scenarios, task-driven activities, cooperative exploration, evaluation and summary, and accompanying tests. This approach enables students to master key concepts, overcome difficult points, and subtly cultivate their disciplinary literacy and civic education skills.

4.4.3. Post-course consolidation

In the post-course consolidation link, teachers can access data from the feedback in accompanying exercises, classroom answers, and other activities on the learning platform. They can then pinpoint student problems and provide individualized learning resources. In addition to teaching, educators must also actively engage with students by promptly answering questions in the dedicated platform's doubt area and utilizing the convenience that technology provides.

Table 1: Teaching process of Automatic Obstacle Avoidance Robot.

Teaching process		Teachers' activities	Student Activities	Technical Support
Pre-course study	Push pre-course materials Post study quizzes	① Push materials: teacher upload micro-lessons on "Conditional Judgment" and related learning resources (news of COVID-19, video on epidemic prevention robots, etc.) to the "Learn Site Learning Platform" for students. ② Publishing quizzes: teacher has uploaded six objective questions on the Learn Site platform to assess students' pre-study.	① Students watch micro-teaching videos on their own. ② Students complete test questions.	Data Precision Analysis
In-class interaction	Teachers create scenarios Students ask questions	① Play a video:teachers show students a video of entering the school gate to do hand disinfection and show students the manual disinfection unit built in science class. ② Question: the teacher asks the students what are the ways in which the	① Students watch the video.	Video software

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		disinfecting device can be made to automatically spray disinfectant?	② Students think about the question.	
	Task-driven approach Student-driven inquiry	① Assign task 1: students write a programme to automate the spraying of disinfectant and test the equipment, and finally complete a commissioning checklist. ② Play animation: introduction of the "Conditional judgement" module. ③ Play the micro-lesson: introduction to adding infrared obstacle avoidance sensors and setting conditional judgement expressions in a program.	① All students read the details of the task, understand the content of the task, refer to the learning resources and complete Task 1. ② Students watch an animation to learn about the Conditional Judgement module. ③ Students watch the micro-lessons to learn how to add infrared obstacle avoidance sensors and set up conditional judgement modules in the program.	Video software
		① Assign task 2: Students write a programme to achieve intelligent spraying of disinfectant, complete the test equipment and fill in the debugging checklist, finally, the teacher invites students to the podium to operate the demonstration programme. ② Question: The teacher asks the students how the conditional expression should be represented if the sensor is replaced by another one?	① Students write codes that enable the intelligent spraying of disinfectant, identify problems in the process of debugging the device and finally fill in the debugging checklist. ② Two students take the podium and demonstrate.	Intelligent sampling system Tablet photo Online Upload Display on the same screen
	Co-operative Exploration Discussion and Sharing	① Product upgrading requirements: add more functions to the disinfection device, and make it more user-friendly and more versatile. ② Assigning the extension task: filling in design checklists, programming for functional diversity, testing equipment.	① Students discuss and share with each other. ② The group works together to complete the task and ultimately create the work. One typist was responsible for completing the design checklist while the other students wrote the programme and debugged the device.	Intelligent sampling system Tablet photo Online Upload Display on the same screen
	Display Report Evaluation Summary	① Evaluation and praise: guide students to log in the learning platform and praise each group's work procedure according to the evaluation form. ② Presentation: the two or three groups with the highest number of votes are selected to present their work. ③ Harvest summary: teacher guide students to summary the gains and insights of the lesson, invite students to speak on the gains. ④ Extension and sharing: Teachers show the application examples of sensors and the "Conditional Judgement" module, leading to "Technology makes life more beautiful and smarter".	① Students view the evaluation form to understand what is being evaluated and to be fair and unbiased in their view of others' work. ② Students log in to the learning platform to evaluate, view group work procedures, like each group's procedures, and recommend groups that present reports. ③ The group with the highest number of votes presents the report group's work and the students listen to the report. ④ Students watch the video.	Learning assessment system Results Sharing Platform Video Software
	classroom test Application Concepts	Teachers push 8 objective test questions on the platform, check students' answers in time, and provide targeted explanations for questions with low correct rates.	Students complete answers on personal tablets.	Online assessment system
Post-class consolidation	Personalised push of resources Answer students' questions	① Teachers check students' answers, identify students who are lagging and push corresponding micro-lessons and exercises to implement remedial teaching. ② Teachers view and answer students' queries on the learning exchange platform.	① Students complete the test questions; ② Students raise doubts and exchange ideas.	Personalised push of resources Learning Exchange Platform

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4.5. "Evaluation" phase

The evaluation stage is crucial for the intelligent classroom teaching model as it provides feedback on the overall learning situation and outcomes. Teaching evaluation allows teachers to reflect on decisions, summarize experience, and improve effectiveness. Students can assess their learning progress, identify gaps, and continuously improve their skills and competencies. Students can monitor their learning progress, identify gaps, and enhance their skills and qualities. In the process of evaluation, there are two types of assessments: formative and summative evaluations [12]. Formative evaluation is conducted throughout the analysis, design, development, and implementation of all the elements of the teaching process. Its purpose is to guide the teaching process towards achieving an accurate and comprehensive evaluation of student learning outcomes and the effectiveness of the teacher's teaching methodology. After the teaching implementation stage, summative evaluation directly measures the results of teaching.

5. Conclusions

With the rise of digital transformation in education, technology has become an essential tool in creating smart classrooms that integrate education with technology. Both the ADDIE model and smart classroom teaching mode are structured and conceptualized around student-centred, cultivating problem-solving ability and creative thinking. This study proposes a smart classroom teaching model based on the ADDIE model, which incorporates digital technology tools to maximize its effectiveness. This study proposes a teaching model for smart classrooms based on the ADDIE model. The model includes the analysis, design, development, implementation, and evaluation stages, and utilizes new digital technology to enhance the teaching effect of "1+1>2". This study aims to provide theoretical guidance and practical experience to scholars and teachers in primary and secondary schools who are interested in smart classroom research.

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