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Teaching Reform and Practice of Database Principles and Application Course Based on the ARCS Motivation Model

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Abstract: Database Principles and Application is a core course for computer science and related majors. Traditional teaching often faces problems such as insufficient learning motivation and disconnection between theory and practice. Taking a university in Hebei Province as an example, this paper introduces the ARCS motivation model and integrates AI tools to enhance teaching interaction. Using the real project “Web Book Management Information System” as a carrier, a motivational teaching design is constructed around four dimensions: Attention, Relevance, Confidence, and Satisfaction. The implementation path in terms of teaching content, methods, and evaluation is systematically described. Teaching practice shows that this model can effectively stimulate students’ learning motivation to a certain extent, and the teaching objectives of each ARCS dimension present a good “high motivation-high mastery” pattern. Finally, prospects are proposed to provide reference for teaching reform of related courses.

1. Introduction

Database Principles and Application is a core course for majors such as computer science and technology, and information management. Its teaching quality directly affects students’ professional ability in data management and system development [1]. With the development of information technology and the continuous updating of educational concepts, how to effectively stimulate students’ learning motivation and improve teaching effectiveness has become a key issue in teaching reform. The ARCS motivation model proposed by Professor Keller of Florida State University in 1983 [2]. Provides a solid theoretical foundation for instructional design and learning motivation research. The model starts from four dimensions: Attention, Relevance, Confidence, and Satisfaction, integrating motivation theory with teaching strategies, which is especially suitable for practice-oriented engineering courses. In response to the requirements of deepening vocational education reform and innovating talent training modes, this study takes the Database Principles and Application course of a secondary vocational school in Hebei Province as the practice field, attempts to introduce the ARCS motivation model combined with AI tools, and constructs a motivational teaching design scheme based on a real project. The aim is to provide a practical reference for teaching reform in similar institutions.

2. Implications and Pedagogical Transformation of the ARCS Model

As a systematic instructional design theoretical framework, the core idea of the ARCS motivation model can be understood at three levels: educational purpose, teaching objectives, and teaching philosophy and methods. At the level of educational purpose, it emphasizes stimulating and maintaining learning motivation, cultivating students into lifelong learners with intrinsic drive. At the teaching objective level, it sets four target systems—Attention, Relevance, Confidence, and Satisfaction. This provides clear guidance for motivational design. At the design philosophy level, it emphasizes knowledge integration through systematic design of context, connection, scaffolding, and feedback, creating a supportive learning environment.

When applying the ARCS model to specific course teaching, the four motivational dimensions are taken as the design main line, with the selected "Web Book Management Information System" as the carrier, systematically reorganizing teaching content, planning teaching methods, designing teaching processes, and constructing a teaching evaluation system. Therefore, this paper formalizes and operationalizes the theoretical framework and deeply integrates it into the concrete practice mode of the Database Principles and Application course.

3. Problems in Current Teaching

At present, the teaching of Database Principles and Application still faces structural challenges, especially in stimulating and maintaining students' learning motivation. From the perspective of the ARCS model, the following main problems can be identified.Attention: Teaching content is often presented in a single manner [3], making it difficult to effectively attract and sustain students' interest.; Relevance: Course content is obviously disconnected from industry technology development and job ability requirements. Students often feel that what they learn is not strongly related to future career development, leading to vague learning goals and insufficient motivation[4];Confidence: The difficulty design of teaching content often has gaps [5], the practice link lacks gradual, step-by-step task support, causing students to easily develop fear of difficulty and reduced self-efficacy when facing comprehensive projects;Satisfaction: The course evaluation system still focuses too much on final written examinations, and process evaluation and diversified feedback mechanisms are not yet well established. Students find it difficult to obtain timely and positive achievement experience and professional identity from the learning process. In addition, the weak school-enterprise collaboration mechanism and practical teaching resource construction in Hebei Province further restrict the deep integration of course teaching with practical application.

4. Teaching Design

4.1. Teaching Content

The core project system of Database Principles and Application includes basic theory and environment, core operations and object management, advanced topics and system assurance, and comprehensive design and engineering practice. This project takes the real project "Web Book Management Information System" from comprehensive design and engineering practice as the carrier, running through the complete development process including requirement analysis, conceptual design (E-R diagram), logical design (relational schema transformation and normalization theory), physical design, system implementation and testing, etc., cultivating students' ability to comprehensively use database knowledge to solve practical engineering problems.

4.2. Student Profile Analysis

The teaching targets are sophomores majoring in computer-related fields at a university in Hebei Province, with a class size of 34 students. The students have basic computer knowledge and skills, meeting the conditions for database learning. However, from the ARCS model perspective: at the Attention level, students tend to feel distracted by abstract theories; at the Relevance dimension, their understanding of the connection between course content and professional value is vague; at the Confidence dimension, gaps in practical steps lead to fear of difficulty; at the Satisfaction dimension, evaluation is mainly based on written exams, with insufficient process incentives. Although the students have programming foundations, they generally show the typical characteristics of “disconnection between learning and application, and lack of motivation”.

4.3. Teaching Objectives

Table 1: Teaching Objectives.

ARCS Dimension	Knowledge and Skills	Process and Methods	Attitudes and Values
Attention (A)	1. Describe the core business process and data requirements of the “Web Book Management System”. 2. Identify key problems in system development.	Watch videos, analyze deficiencies of existing systems, conduct group discussions and propose improvement ideas.	Stimulate curiosity about solving practical problems with database technology, develop awareness of active observation and problem identification.
Relevance (R)	1. Transform business requirements into an E-R diagram. 2. Understand the relationship between conceptual model and subsequent implementation.	Through case analysis, map real business actions (e.g., “borrow”, “return”) into entities and relationships in the conceptual model; conduct group scheme demonstration.	Establish the recognition that database design is closely related to real-world business needs, appreciate the value of technology serving specific scenarios.
Confidence (C)	1. Convert E-R diagram to relational schema and apply normalization theory for optimization. 2. Use SQL Server to create databases, tables, and perform basic data operations.	Based on the design framework and code templates provided by the teacher, complete the practice from logical design to physical implementation step by step, debugging common errors.	Build successful experiences through gradually completing tasks, cultivate rigorous engineering design habits, and overcome fear of complex system development.
Satisfaction (S)	1. Implement stored procedures and triggers. 2. Design and implement backup, recovery, and user permission management schemes.	Complete a runnable prototype system, conduct inter-group presentation and peer evaluation; write a brief system deployment and maintenance document.	Gain a sense of achievement from project implementation and presentation, enhance professional identity for positions such as database administrator.

Based on industry standards and curriculum standards, this course sets teaching objectives tailored to students’ actual situation, including knowledge and skills, process and methods, and attitudes and values. The specific objectives are shown in Table 1.

4.4. Teaching Implementation

4.4.1. Teaching Process

The teaching process of this course takes the "Web Book Management Information System" database project as the main thread, and is designed and implemented in stages closely around the four dimensions of the ARCS motivation model, with AI teaching support incorporated at each stage to enhance the sustainability of motivation stimulation and learning efficiency.

Attention Stage: Situation Introduction and Requirement Analysis.At the beginning, the class attracts students' attention by playing comparative videos to create cognitive conflict. AI-generated case videos are also used to further create cognitive conflict and effectively attract students' attention. Then the teacher guides students to act as "system analysts" in groups to discuss core business flows such as "book borrowing", identifying pain points like "data redundancy". The teacher guides students to summarize and refine scattered business requirements into a standardized data requirement specification, and introduces the entity-relationship (E-R) model as core knowledge, allowing students to preliminarily learn how to abstract the real world using "entities", "attributes", and "relationships". By binding abstract database concepts with a discussable real problem domain, students clarify their goals from the very beginning, laying a meaningful foundation for subsequent in-depth learning.

Relevance Stage: Conceptual Design and Logical Transformation.In this stage, teaching naturally transitions to the solution design phase. The teacher guides students to visually express the requirements produced in the previous stage using an E-R diagram, completing conceptual structure design. The teacher explains in detail the mapping rules of "entity to table", "relationship to table" or "foreign keys", and naturally introduces normalization theory (normal forms). By analyzing possible insertion and deletion anomalies in their own initial table structures, students deeply understand the necessity of applying 1NF, 2NF, and even 3NF for optimization. This stage builds the relevance between theoretical knowledge and engineering practice, enabling students to experience the direct value of "learning is immediately useful". Students draw E-R diagrams to complete conceptual design, and then learn to convert E-R diagrams into relational schemas. AI concept map generation tools can assist drawing and provide intelligent suggestions for normalization design, helping students intuitively understand the mapping from theory to practice and reinforcing the cognitive association of "learning is usable".

Confidence Stage: Physical Implementation and Function Development. This stage is the core hands-on practice for students. Tasks are designed as a clearly progressive sequence: guide students to use Data Definition Language (DDL) to create the project database in SQL Server, create tables strictly according to the logical design, and implement PRIMARY KEY, FOREIGN KEY, CHECK, etc., turning theoretical integrity rules into code-level enforcement (basic tasks); guide students to use Data Manipulation Language (DML) and Data Query Language (DQL) to write INSERT statements to initialize data, and complete from simple single-table queries to complex multi-table JOINs and nested subqueries to realize business functions such as "query all borrowing records of a reader" and "count book inventory by category" (advanced tasks); introduce advanced programming knowledge of stored procedures and triggers. The teacher demonstrates how to encapsulate a "borrow book" business into a stored procedure with parameters and transaction characteristics, and how to create triggers to automate rules like "automatically reduce inventory when borrowing" and "automatically calculate late fees when returning" (high-level tasks). Each subtask is equipped with detailed step-by-step guidance, code fragment references, and common error troubleshooting guides. Students complete database creation, SQL programming, and advanced function development such as stored procedures and triggers. AI programming training platforms can play an important role here, providing adaptively difficult tasks and real-time feedback, such as automatically detecting SQL logic errors and giving optimization suggestions, helping students accumulate successful experiences through small iterative steps and gradually enhance technical confidence.

Satisfaction Stage: System Integration, Evaluation & Presentation, and Transfer Reflection.At the end of the project, an AI project evaluation system is introduced to provide automated preliminary scoring on dimensions such as code standardization and functional completeness, combined with teacher comments and peer evaluation, forming a multi-dimensional, immediate feedback system. Evaluation is conducted according to multiple criteria including design plan completeness, system function realization, code standardization, and teamwork performance. At the same time, student self-evaluation and inter-group evaluation mechanisms are introduced. Outstanding project results will be displayed and may be recommended for school-level competitions or used as course models. Finally, the teacher guides students to reflect on extended questions such as “If the system’s number of readers increases tenfold, how should the database be optimized?” to promote knowledge transfer. Through this complete “design-implement-present-recognize” loop, students gain deep satisfaction and professional identity from the tangible project results, diverse positive evaluations, and potential extended value, thus effectively transforming external learning motivation into internal exploratory interest and professional responsibility.

4.4.2. Teaching Evaluation

This course evaluates students’ learning outcomes from the four ARCS dimensions, and adopts a multi-evaluation system including self-evaluation, peer evaluation, and teacher evaluation. During the evaluation process, some standardized content (e.g., SQL statement standardization, E-R diagram completeness) is automatically assistively scored using AI tools to improve efficiency and objectivity. Teachers then provide comprehensive qualitative evaluations, fully examining students’ performance in motivational engagement, knowledge and skills, engineering literacy, and progress and transfer. The analysis of teaching effectiveness achievement shows that students’ scoring rates in all four dimensions exceed 80%, with “learning motivation engagement” scoring the highest (85.4%), indicating that the attention and relevance strategies of the model effectively stimulated students’ intrinsic interest and perception of learning value. The high scoring rates in the knowledge and skill dimensions (database design 82.2%, SQL programming 80.4%) confirm that students have built a solid ability foundation in the “confidence” dimension. This “high motivation-high mastery” data pattern, together with an overall comprehensive scoring rate of 82.3%, constitutes empirical evidence that the ARCS motivation model successfully drives learning outcomes, indicating that the design not only enhances students’ sense of participation but also substantially translates into measurable knowledge and skill growth.

4.4.3. Teaching Effectiveness

From the perspective of teaching effectiveness, students applied database principles and SQL programming knowledge to the “Web Book Management Information System”, completing tasks from requirement analysis, conceptual design, physical implementation to function development. Theoretical knowledge and practical operation achieved deep integration, and system design and problem-solving abilities were effectively exercised. Through the project-driven stepwise training and diverse evaluation incentives, students performed outstandingly in database-related skill competitions at various levels, achieving good results, reflecting not only mastery of core knowledge but also solid engineering practice literacy. Students can propose feasible ideas for function expansion or performance optimization of the project, and receive positive feedback during enterprise internships, demonstrating clear database engineering thinking and good professional adaptability. These results indicate that the motivation design based on the ARCS model effectively stimulated students' intrinsic motivation, innovation awareness, and professional responsibility, laying a solid foundation for them to adapt to the technological development needs of the digital intelligence era.

5. Conclusion

In response to the problems of insufficient motivation and disconnection between knowledge and action in traditional database course teaching, the deep integration of the ARCS motivation model with the teaching of Database Principles and Application is introduced, providing a systematic path to solve these problems. Using a real project as the carrier and combining AI teaching tools, motivational design and practice are carried out, effectively improving teaching effectiveness. In the future, we can further explore the deep integration mechanism of the ARCS model with intelligent education technologies and conduct long-term tracking research to promote the continuous development of course teaching towards intelligence and precision.

Fund Project

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