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Research on Blending Learning Flipped Class Model in Colleges and Universities Based on Computational Thinking — “Database Principles” for Example

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ABSTRACT

Computational thinking is to use heuristic reasoning to seek the solution of the problem, and has a strong ability to innovate. In the teaching of computer courses, it is one of the important subjects of teaching research to cultivate students' computational thinking ability. The traditional teaching model ignores the cognitive role of the students, which is not conducive to the cultivation of students' innovative thinking and creative ability. Blending learning is an inevitable trend of development in the field of higher education, and a hot research topic in the field of education. Inspired by “Database Principles” course model at University of Missouri, Kansas City, a multi-dimensional blending learning flipped class model of computer courses in colleges and universities based on students' computational thinking ability is proposed to construct teaching model and design theoretical and practical teaching system and diversified teaching process evaluation system. In the course of “Database Principles”, the teaching practice is carried out to verify the teaching effect.

Keywords: blending learning, flipped class, database principles, computational thinking, teaching model

INTRODUCTION

In the traditional teaching mode, the teacher is the subject of teaching activities and the initiator of knowledge, while the students are in a passive position to accept. This teaching model ignores the cognitive role of students, and it is not conducive to train students' innovative thinking and innovative ability. With the rapid development of educational information technology and the continuous updating of educational ideas, schools and teachers pay more attention to the individualized development, the cultivation of innovative ability and the improvement of

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State of the literature

- Blending learning (Wang, 2013), flipped class model (Cilli-Turner, 2015) conform to the idea of teaching reform, and have brought new ideas to the college computer teaching.
- Inspired by the course model of “Database Principles” in the school of engineering and information technology at the University of Missouri in Kansas City, the author proposed a multi-dimensional blending learning flipped class model for the cultivation of students’ computational thinking ability combining the teaching situation of “Database Principles”.

Contribution of this paper to the literature

In the survey of several universities in China, the author finds that there are several problems in the teaching of “Database Principles”:

- The phenomenon of “paying more attention to teaching instead of practice” still exists in teaching, which leads students to grasp only the basic principle and lack practical practice ability after the course has been completed.
- In teaching methods, in spite of the introduction of a variety of multimedia technology, the traditional “cramming” mode is still there. Due to the change from “chalk+ blackboard” to “computer+ screen projection”, students are tired of information bombardment in the whole teaching process, completely fail to develop their learning initiative.
- In the teaching of “Database Principles”, most of experiments are simple confirmatory experiments, few design and comprehensive ones. Moreover, the experiment time is short, the content is relatively simple, and they are very different from the real engineering practice environment, and difficult to meet the requirements of industry standards for database application technicians.

comprehensive quality of students. Adhering to the core concept of promoting the integration of information technology and education and teaching has become the key point of educational informatization in the world.

Therefore, the traditional teaching model is not conducive to train students’ innovative thinking and innovative ability. Students cannot internalize and study the knowledge of this course. After graduation, they cannot achieve seamless docking with employers.

CONNOTATION DEFINITION AND COMPUTATIONAL THINKING OF FLIPPED CLASSROOM, BLENDING TEACHING

Flipped Classroom

Flipped classroom is often called “reverse class” and so on. The original idea came from two chemistry teachers Jonathan Berman and Aaron Sams of Woodland Park University. The basic idea is: the traditional learning process is turned over so that learners can finish their autonomous learning for knowledge points and concepts after class; the classroom becomes a place for teachers to interact with students, and it is mainly used to solve doubts and report discussions so as to achieve better teaching results (Ma, 2013). Flipped classroom pays attention to the learning process, and the study time is re-planned. Before class, students go on with self-learning through the personalized collaborative learning environment provided by teachers, such as micro video, animation, online games based on the curriculum content, electronic materials, digital learning platform and other media resources; in class, students internalize knowledge through project discussions and other activities. This provides students with personalized learning space and a variety of ways of learning, so that they can arrange their learning time according to their own circumstances, and realize the sharing of resources. At the same time, the flipped classroom changes the roles of teachers and students. Teachers are the instructor and curriculum designers, not only need to provide high-quality learning resources, but also to help students to achieve autonomous learning, encourage collaborative learning among students, and to stimulate students’ interest in learning through incentives, improve their participation, promote the transformation of the students’ role as “learning center”, and let the students have more experience. This method reverses the traditional classroom teaching in class, listening to the teacher, doing homework after class; reverses the two stages of knowledge transfer and knowledge internalization in traditional

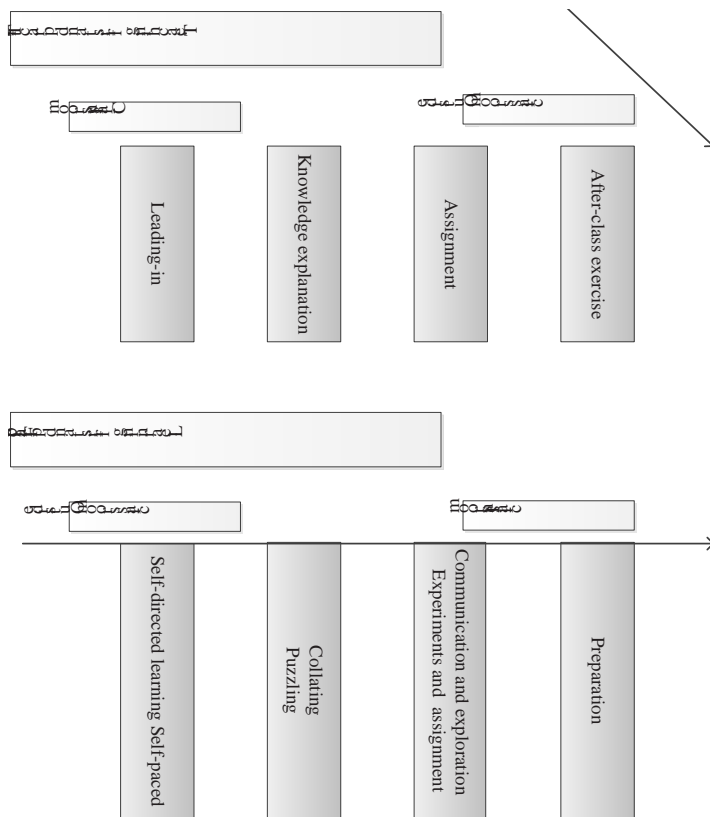


Figure 1. Comparison of changes in the structure of the traditional classroom and the flipped classroom

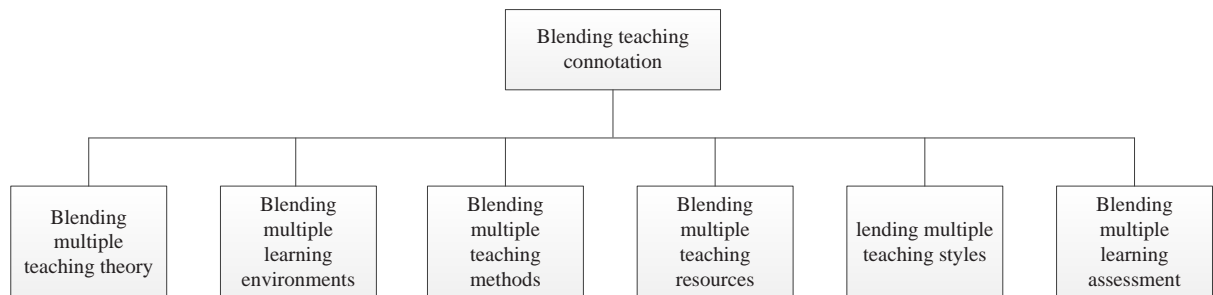


Figure 2. The connotation of blending teaching

classroom; changes the role of teachers and students and the traditional teaching structure and teaching process; embodies the basic idea of constructivism; greatly stimulates students’ learning motivation and improves classroom participation (Lakmal, 2014). The comparison of changes in the structure of the traditional classroom and the flipped classroom are shown in **Figure 1**.

Blending-Learning

At present, scholars and experts have different emphases on the definition of “blending teaching”, to sum up, there are: blending of multiple teaching theories, blending of multiple learning environments; blending of multiple teaching methods; blending of multiple teaching resources; blending of multiple teaching styles, blending of multiple learning assessments and so on, as shown in **Figure 2**.

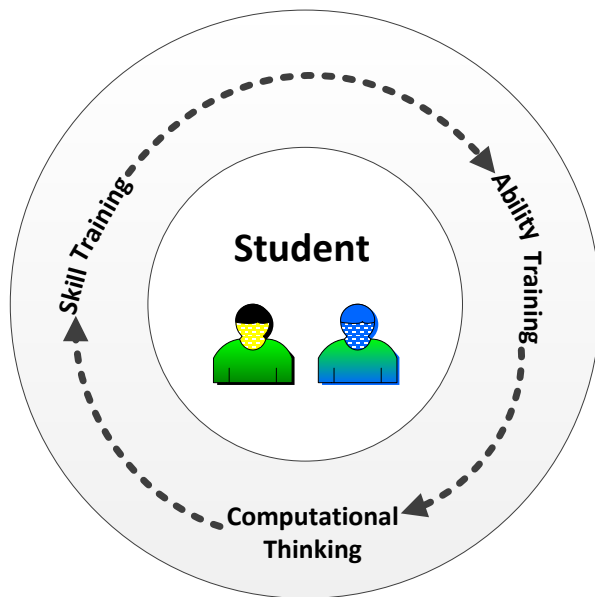


Figure 3. The forming process of students' computational thinking

Computational Thinking

Professor Zhou Yizhen (Jeannette M. Wing) at Carnegie Mellon University in the United States put forward the concept of Computational Thinking for the first time in 2006. She believes that computational thinking is a series of thinking activities covering the breadth of computer science with the basic concepts of computer science, such as problem solving, system design, and human behavior understanding (Jeannette, 2006). Professor Zhou further pointed out that computational thinking was the basic skill for each of us to survive, just as we do when we read and write. The cultivation of students' computational thinking ability is an important subject in the educational field (Jeannette, 2006). In 2010, Professor Chen Guoliang, a member of the Chinese Academy of Sciences, pointed out in the Sixth University Computer Curriculum Report Forum of China, an important task of cultivating innovative talents was to subtly let the students to solve problems, design systems and understand behavior using the basic concepts of Computer Science, that is to say, to establish the way of calculating thinking (Richard, 2012). In the revised computer science tutorial 2008, computational thinking is listed as an important part of computer science teaching by IEEECS and ACM (Johnathan, 2013).

The formation of computational thinking is shown in [Figure 3](#). When using computational thinking method to solve relevant problems, students should first master the knowledge structure of the problem through skills training; under the premise of having a certain study background and thinking ability, a series of methods of computational thinking are used to analyze the whole problem knowledge system, get the solution of the problem, and verify the correctness of the scheme, so as to internalize this thinking. Then, "skill training-ability training-computational thinking formation" reacts again to other problems and makes computational thinking part of their skills. From the training of knowledge and skills to the training of ability, and to the formation of computational thinking, it is a process of mutual promotion and a cycle process.

TEACHING MODEL OF "DATABASE PRINCIPLES" COURSE AT UNIVERSITY OF MISSOURI, KANSAS CITY

Teaching methods for the course of "Database Principles" course at School of Electrical Engineering and Information Science, University of Missouri, Kansas City include lecture, tutorial, seminar, presentation and discussion. The teaching process of the whole course is centered on students, and the whole course takes a blended flipped teaching model. It pays great attention to the cultivation of students' computational thinking.

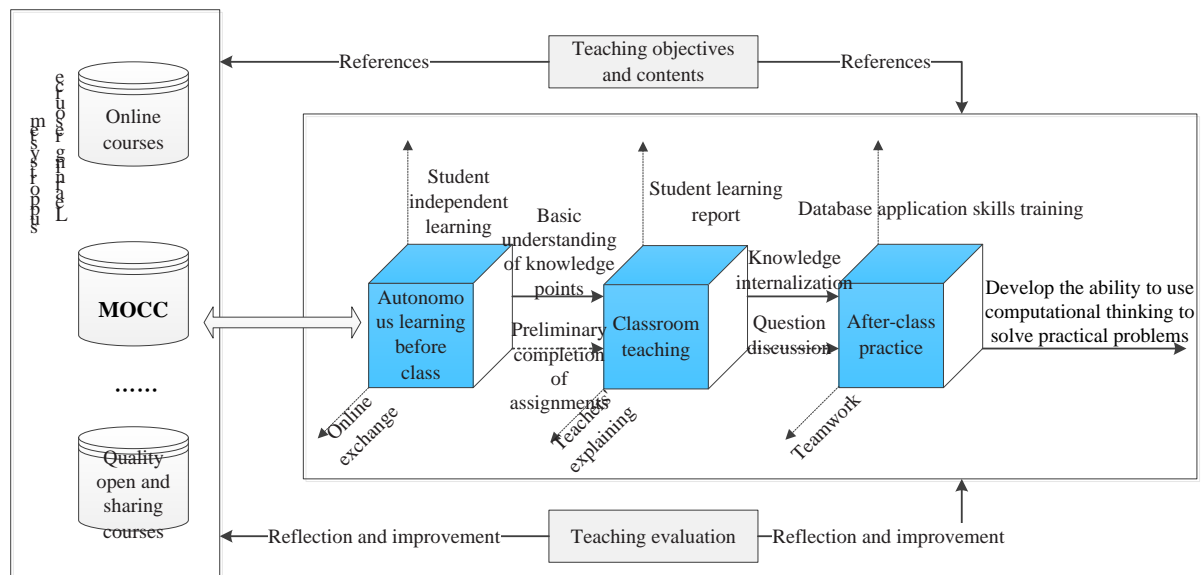


Figure 4. Multidimensional blended flipped teaching model of “Database Principles” facing to the cultivation of computational thinking ability

Firstly, before class, the teacher will share the courseware, teaching emphases and difficulties of each course online through MOOC and so on. Students will prepare lessons before class focus on the key points and difficulties. Then there is the lecture section, which is basically the same as that of the Chinese University. The instructor thinks the students have prepared the contents before the class. Therefore, in the classroom, the instructor’s explanation is very fast, only for the key and difficulties. And lecture section corresponds to the tutorial section, basically every section of the lectures have a tutorial class, this lecture class is divided into 8 small remedial classes. The teaching of the tutorial course is undertaken by another teaching assistant. The discussion is carried out for the content of the course. The atmosphere is very active. The tutor is mainly listening and guiding, and the explanation is no longer the main reason. The seminar is that the teacher sets up several subjects for students to discuss in groups according to the content of the teaching, and the students are grouped according to their individual interests. Each group has a population of 5 to 6. The group members discuss one or more topics and then the teacher summarizes. In the presentation section, the students take turns to report and explain the questions, then the other students ask questions about the report, and then the teacher concludes. The discussion section is the question answering class. Teachers and teaching assistants prearrange time and place, answering questions for students in the learning process especially the problems encountered during the process of doing homework. Therefore, “Data Principles” course at the University of Missouri, Kansas City, reflects the teaching methods of communication, innovation, cooperation and critical thinking.

MULTIDIMENSIONAL BLENDED FLIPPED TEACHING MODEL OF “DATABASE PRINCIPLES” COURSE FACING TO THE CULTIVATION OF COMPUTATIONAL THINKING ABILITY

Drawing on the experience of teaching methods of “Database Principles” course at the University of Missouri, Kansas City, combining the actual teaching situation of “Database Principles” course at universities in China, under the guidance of computational thinking, blended learning and flipped classroom teaching ideas, a multidimensional blended flipped teaching model structure of “Database Principles” course facing to the cultivation of computational thinking ability is put forward in this paper which is implemented from three levels, namely self-learning before class, teaching in class and practice after school, and multiple dimensions. The teaching model structure is as shown in **Figure 4**.

The structure of a multidimensional blended flipped teaching model of “Database Principles” facing to the cultivation of computational thinking ability proposed in this paper is described in details in [Figure 4](#). To sum up, the teaching model mainly includes the following steps.

Determining Teaching Objectives and Teaching Content

In the structure of multidimensional blended flipped teaching model, a variety of teaching content and diverse teaching objectives are determined according to the diversified needs of students, starting from the training of computational thinking ability (Rong, 2015). Whatever it is learning resources making by the teachers for the students in the early stage, or the self-study, classroom teaching and practice after class, the teaching and learning of each stage cannot be separated from the instruction of the teaching objective, the implementation of teaching tasks at each stage refers to the teaching objectives and teaching content. The course teachers of “Database Principles” also have certain information technology literacy, can accurately extract knowledge points, will skillfully produce multimedia teaching resources, such as teaching courseware, teaching video, MOOC and so on.

Autonomous Learning before Class

The autonomous learning before class is one of the good supplements of classroom teaching, since it can not only enable students to develop the habit of active learning, but also effectively extend the time and space of learning. Before instruction, teaching courseware, teaching videos, MOOC and other teaching resources related to the course are shared with students. Students first receive the teacher’s teaching tasks, and preliminarily complete knowledge learning and understanding through these online learning resources. In the section of autonomous learning before class, in order to avoid students learning deviation from the teaching objectives, teachers need to undertake online questioning and guidance work, while students should actively communicate with their classmates or teachers online to achieve the basic understanding of the course content and preliminary completion of the assignments. Students can also record problems encountered by self-study before class, bring problems to class, and ask teachers or classmates to help them face to face. Through the autonomous study before class, students’ autonomous inquiry consciousness and team cooperation ability are fully developed. Students change from passive listening in class to active discovery learning before class. The students have mastered the knowledge they have learned, and the entire teaching content was advanced by one beat.

Classroom Teaching

The main part of classroom teaching is knowledge internalization, occupies a large proportion in the course of the multi-dimensional mixed flipped classroom teaching, and plays an important role in fostering students’ interest in learning, computational thinking and creative awareness. Therefore, teachers should carefully carry out classroom teaching design, so as to arouse students’ interest and potential. In class, the teacher can start the process of teaching or the process of learning based on computational thinking. The teacher goes deep into the student to interact with the student, and gives the initiative of the class to the student, trains the student’s independent study ability and the cooperation consciousness. Students report to the teacher about the degree of understanding and operation of the knowledge, or ask the teacher about the problems encountered in the course of study, and the teacher gives answers in a timely manner. In class, students can also discuss a particular point of knowledge deeply. It can be seen that through classroom teaching, students can develop themselves in the process of learning, achieve knowledge internalization, and students’ thinking ability of calculation is trained, and the perspective of computational thinking is condensed.

After-Class Practice

After class practice is an important part of training students’ database application skills, and is the practical application of theoretical knowledge. According to the characteristics of the course “Database Principles”, the theory of curriculum is combined with curriculum experiment and after class practice, so that students can master and verify the theoretical knowledge acquired in the course of practice. After class, the students are usually asked to apply the knowledge they have learned to establish some conceptual, structural design models and logical

Table 1. Grade evaluation criteria of “Database Principles”

Learning attitude	25%	
Training result (Imitate, consolidate, improve)	55%	Usual grades 80%
Online learning file (Task) phase testing		
Final comprehensive assessment		20%
Online interaction (additional)		<= 10 points

structure design models for practical problems, and then develop the database application system. Therefore, this practical process can train students’ mathematical modeling ability, programming ability and database application system development ability, enable them to develop good computational thinking quality, and further strengthen their computational thinking ability, which embodies the value of computational thinking.

Establishing a Diversified Teaching Process Evaluation System

A good teaching model cannot be separated from the test of teaching evaluation. Through the teaching evaluation, we can constantly revise and perfect the teaching program, and make the teaching mode more effective (Huang, 2016). In the course of teaching the course of “Database Principles” in the multidimensional blended flipped teaching model, in order to make the teaching effect better, a process evaluation mechanism has been established and evaluated continuously in the course of teaching. Process assessment can keep abreast of each stage of the teaching situation and students’ learning progress. According to the feedback information, timely adjustment or improvement of the existing problems are made to further improve the teaching mode. At the same time, in order to evaluate the final grade of students more reasonably and scientifically, a diversified examination evaluation system will be established. The evaluation criteria are shown in [Table 1](#).

PROPHASE IMPLEMENTATION OF MULTIDIMENSIONAL BLENDED FLIPPED TEACHING MODEL OF “DATABASE PRINCIPLES” COURSE FACING TO THE CULTIVATION OF COMPUTATIONAL THINKING ABILITY

Under the guidance of multidimensional blended flipped teaching model of “Database Principles” course facing to the cultivation of computational thinking ability presented in this paper, the multidimensional blended flipped teaching of “Database Principles” course has been implemented in a part of majors at Suzhou University, Anhui, China. The research shows that this teaching model can stimulate students’ learning motivation and promote the learning effect of students. The preparations are as follows:

In order to facilitate students to study the content independently, taking the independent knowledge point as a unit, the teaching task of the multidimensional blended flipped teaching model was formulated. First of all, according to the syllabus, a detailed teaching task was formulated. According to the knowledge structure, the whole course content was divided into 9 modules, and each module was divided into a number of knowledge points. There is a certain relationship between modules, and each module is connected in series to form the content of the whole course. The course structure setting of “database principles” is shown in [Table 2](#).

In addition, teachers have made courseware and MOOC teaching resources according to the division of knowledge, collected many network resources related to the course of “database principles”, which have been published on the online teaching platform for students to study independently. In order to further stimulate the enthusiasm and initiative of students, some database applications developed by previous students are also shown to students in this platform.

Table 2. Course structure setting of “database principles”

Teaching module	Knowledge points	Contents
Database technology overview	4	Data management, database systems, data models, schema structures
Relational database	3	Relational data structures, integrity constraints, relational algebra
SQL	7	Data definition, simple query, nested query, set query, view creation, view modification and view query
Database security	7	Security standards, user identification and authentication, access control, authorization and recovery, database roles, view mechanisms, audits
Database integrity	4	Entity integrity, reference integrity, user defined integrity, triggers
Relational normalization theory	5	Function dependencies, 1NF, 2NF, 3NF, relational schema decomposition
Database recovery technology	6	The definition and characteristics of transactions, faults, recovery, data dumps, log files, database mirroring
Concurrency control	6	Lost update, unrepeatable read, dirty read, lock type, two-phase locking protocol, lock granularity
New development of database technology	2	Database technology, big data

Table 3. Student satisfaction survey data sheet

S/N	Questions	Options	Sample / percentage
1	What do you think of the effect of multidimensional blending teaching model based on computational thinking?	Very good	18 (75%)
		General	6 (25%)
		Very bad	0 (0%)
2	Do you think that the multi-dimensional blended flipped teaching model based on computational thinking can help you develop your independent learning ability?	Very helpful	14 (58%)
		General	9 (38%)
		Not helpful	1 (4%)
3	Does the multidimensional blended flipped teaching model based on computational thinking make you be more interested in the course of database principles?	More interested	20 (83%)
		No influence	4 (17%)
		Lose interest	0 (0%)
4	Is the multidimensional blended flipped teaching model based on computational thinking helpful for you to develop the habit of active learning?	Very helpful	16 (67%)
		General	7 (29%)
		Not helpful	1 (4%)
5	Does the multidimensional blended flipped teaching model based on computational thinking help you better apply the principles of database learning to solving practical problems?	Very helpful	13 (54%)
		General	10 (42%)
		Not helpful	1 (4%)
6	Do you like to continue the current multi dimensional blended flipped teaching model based on computational thinking?	Like	19 (79%)
		General	5 (21%)
		Dislike	0 (0%)

IMPLEMENTATION EFFECT ANALYSIS

Taking undergraduates of grade 15 of computer science and technology in Suzhou University as the object of study, the use of online learning platform was statistically analyzed. Take digital learning platform as an example, the students have the highest number of visits this semester, 4304 times, the lowest 1139 times, an average of 2033 times; with the total residence time of 45265.4 minutes, the shortest 6411.45 minutes, the average 17011.03 minutes. This shows that after the application of flipped classroom blended teaching model, the use of digital learning platform is very high, students will study independently, and learning enthusiasm is higher.

In addition, according to the "Database Principle" course, questionnaires and random interviews are used to understand the students' satisfaction with the blended teaching model based on flipped classroom. **Table 3** is the questionnaire of student satisfaction survey.

CONCLUSION

Guided by the blending learning theory and flipped classroom teaching model, drawing lessons from the mixed flipped classroom teaching model of Database Principles at the University of Missouri, Kansas City, a multidimensional blended flipped teaching model suitable for "database principles" for computational thinking ability cultivation in Chinese institutions of higher learning is proposed. The connotation, system structure and teaching process of the model are studied from three levels of autonomous learning before class, teaching in class and practice after class around multiple dimensions. It provides a theoretical basis for reforming the teaching concepts of "database principles", improving teaching quality and effect, and can effectively improve the design and development capabilities of students' database application systems.

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