

The Practice of Interactive Teaching for Software System Analysis and Design Course

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Abstract—Aiming at the problems in traditional cramming teaching, this paper discusses how to carry out the interactive teaching practice in software system analysis and design course. The interactive teaching mode covers the problem decomposition, case teaching and team-based interactive practice. The mode has been carried out for multi-years, and achieved a sound teaching effect.

Keywords—*interactive teaching, case teaching, team-based interactive practice*

I. INTRODUCTION

Professors have lectured for centuries in the university. In the traditional teaching mode, professors, as the major role, have to organize classroom activity, and lecture theory and practice; while students are usually the passive information receiver who just listen in class, and finish tasks after class. This mode has some effects on passing on theoretical knowledge, while it is hard to develop student's self-awareness and innovation ability due to lack of active participation and thinking during the whole teaching process. The difference between university and primary or secondary education is to cultivate student's initiative innovation ability and stimulate their potential for raising useful talents. So, the traditional teaching mode with teachers acting as the major role is difficult to meet the needs of talent training in the new era. Interactive teaching mode conforms to social development, emphasizes student's positive participation during the teaching process, respects to the main position of students, and tries to achieve the interaction between teachers and students, students and other students so as to achieve the ultimate goal of education, such as raising innovative talents[1].

II. INTERACTIVE TEACHING MODE

The "interactive teaching mode" is a teaching structure model aiming at cultivating student self-awareness and innovation ability, "letting students love for studying, learn how to study, and be good at study". The idea is to take teaching process as a way for emotional exchange and communication between teachers and students, which is dynamic, developing and unifies teaching and learning [2]. In this process, the relationship between teachers and students is developed and a teaching structure model is formed which promotes harmonious student's interaction between teachers and students, and among individual

students as well as personal study's environment, thus guaranteeing resonance and effectiveness of teaching [3].

A. Main Teaching Methods

In the practice of interactive teaching mode, different teaching methods are involved, and the teaching objectives to be achieved by each method are also various. Different teaching activities should be organized according to the teaching objectives and contents. Some of these activities are led by teachers, some are driven by students, and at different stages of the implementation, corresponding methods should be adopted.

1) *Teacher Lecturing Theories and Methods*: Teaching activities must be started by teachers, and the interactive teaching process is based on the initiation of teachers. Teachers should first introduce the new knowledge points, and let students basically understand the contents through lecture, making students "get a foot on the door". However, different from the traditional teaching, in the interactive teaching mode, it's necessary to compress hours of theory courses on a large scale, extract the outline, and specific theories are not explained in detail for the goal of just explaining basically theories and problems. These questions for students will serve as the basis for the following interactive practice stage. In addition, teachers may also offer a large amount of supplementary materials or references, asking students read after class by themselves to obtain technical reserves for subsequent interaction.

2) *Student Self-learning after Class*: By improving the aspect of student's self-learning, the main body of learning should be changed to students. Students are able to understand knowledge points, discover existing problems, and be prepared for the next stage of interaction through learning textbooks and references.

3) *Student Team Practice and Interaction*: As the main part of interaction, students launch various types of interactive practice in form of team. Students need to organize their teams according to their interests and abilities, complete the practice. During the practice, team members divide tasks and cooperate with each other.

4) *Communication and Interaction Between Teachers and Students*: Students communicate and discuss with teachers with problems found in their study and practice to realize interaction between teachers and students. Consequently, they can deeply understand and grasp

relevant concepts and methods through the practice. This is a very crucial step in the interactive teaching mode. There are many unavoidable problems when practicing, as students have the pressure to complete practice. Teachers can organize different forms of interactive communication around these issues, let students self-think problems they are facing, and find out methods to solve problems during interaction.

5) *Teachers making summaries and comments:* After rounds of practices and communications, students should finish the practice and submit complete artifacts. Teachers review and correct student's artifacts, give feedback on problems, make comments and summaries towards common problems, so that students can deepen their comprehension.

B. Teaching Organization Forms

In order to effectively organize various teaching methods, it is necessary to adopt an appropriate organizational form to drive the interactive teaching process.

1) *Problem Driven:* In order to take advantage of student's initiative, clear problems should come up at each interactive stage [4]. At the beginning of semesters, teachers should make detailed agenda and list main problems at each stage. Students should learn and explore with questions, find out solutions at the end to get grades in this stage by understanding and analyzing problems.

2) *Case Study:* Problems must be integrated into specific cases, and student's practice process is centered around cases. Different types of cases can be designed according to the requirements, including comprehensive cases throughout the whole course and partial cases involving some knowledge points. Students carry out interactive teaching activities by taking cases as backgrounds.

3) *Team Practice:* In addition to the interaction between teachers and students, it's also necessary to give full play to interaction between students, and the most effective way is the team practice. Students set up teams according to their hobbies and specialties. Team members work together to complete teaching tasks [5]. Teams can also organize peer evaluations, review artifacts from other teams, and deepen their comprehension towards the process of practice on the basis of understanding others' work.

III. IMPLEMENTATION OF INTERACTIVE TEACHING MODE

After establishing a basic interactive teaching model, we have explored and implemented this model in software system analysis and design course which was taught in the undergraduate third year in software engineering major at Beihang University. Since 2014, four rounds of practice have been carried out. Practice achievements of first three years were published at the National Computer Education Conference in 2018 [6] and awarded the Outstanding Paper Award. In the past two years, the further standardization of

various interactive teaching methods and organization forms, gradually stabilized and corresponding procedures and standards of operations were formed. In addition, new teaching cases and a collaboration teaching platform were developed. This paper will focus on and introduce the final practical scheme that has been gradually stabilized in the past two years through three aspects: problem decomposition, case design, and scheme implementation.

A. Problem Decomposition

In order to facilitate multiple rounds of the interactive teaching, the teaching content should be first divided into some knowledge points, towards which problems and cases are designed to arrange the implementation plan.

According to requirements of the undergraduate training program from the school, this course is designed to develop student's 5 kinds of abilities: problem analysis, solution design, researching, using modern tools, and communication. Thus, the course's objective is to develop software requirements analysis and system design abilities as well as researching, tool using and team communicating. These can be subdivided into 6 teaching knowledge points when combined with the specific practice process. The part of software requirements analysis can be divided into 3 knowledge points: requirement elicitation, requirement specification and system analysis. System design can be divided into 2 knowledge points: architecture design and object design. Finally all design solution should be implemented.

1) *Requirement Elicitation:* It mainly involves various types of methods for requirement elicitation, through which students carry out requirement, obtain the first-hand information on system requirement, and determine system boundaries.

2) *Requirement Specification:* Using the requirement modeling techniques to document system requirement, and a complete requirement analysis specification is prepared as input for subsequent system design and implementation.

3) *System Analysis:* Using object-oriented analysis to model system requirements, analyzing and understanding requirement, clarify problems, as well as providing materials for system design.

4) *Architecture Design:* Combine systeming architecture design techniques, choosing implementation platform, building system architectures and solutions for system's key problems.

5) *Object Design:* Designing implementation details based on architecture design, including user interface design, database design and class design.

6) *System Implementation:* Following the system design decisions, using programming languages to implement the target system, so that achievements of learning and practice in previous stages are realized to verify the correctness of system analysis and design.

B. Case Design

As the core of interactive case teaching system, teaching case is crucial, and good cases can effectively promote course teaching and practical activities smoothly[7]. There are several possible ways to choose a case: students selecting topics independently, teachers providing several cases, as well as teachers providing only one comprehensive case. The advantage of students self-selecting topics is that students can choose topics based on their interests, which has a certain effect on the students' enthusiasm in practice. However, it's hard to ensure the difficulty of selected topics and coverages of knowledge points, which is inappropriate for practice driven teaching process. The second way is to provide several cases for selection, so that students have right to choose a suitable case. However, there are differences in the methods and techniques for different topics, which makes it difficult to control practice activities, case comments and discussions. To this end, this course adopts the way that only a comprehensive case is provided, and all students complete the same case, so that student discussion, case assessment, etc. are able to follow the same standard, which is convenient to carry out teaching process.

The next step is to design the specific comprehensive case. The chosen case should firstly cover the course knowledge points to serve the course objectives. On the basis, it should be taken into consideration that the case's business background should be neither too familiar nor too strange for students. There wouldn't be much work to requirements elicitation, analysis and so on if students are very familiar with the field. So, it's not recommended to choose a system concerned with college affairs, such as library, educational administration, etc.. So, selecting a field that is relevant to student's daily life but students don't know about details very well. At the same time, in order to reflect the case's engineering characteristic, the designed case should come from actual engineering project, preferably from adaptations at teachers' undertaking engineering project. Moreover, for purpose of ensuring the case keeping step with the trend of technological development, the case also needs to be continuously updated. One case is generally used for latest years. The latest case is the technology scholar resource sharing platform. The original requirement comes from the abstraction of the author's projects in past few years. The project field is related to scientific research, with which undergraduates is not very familiar, but has some contacts. And the project involves some current mainstream technologies, such as big data analytics, web crawler, and relational network. For previous year, cases included various information systems including the unified hospital's appointment registration platform, the national internet bar monitoring system, the real estate agency system, etc.

C. Implementation

The overall implementation is shown in Figure 1. In the preparation stage before the course initiation, problem decomposition and case design would be done. A complete syllabus and teaching agenda would be

announced to students in order to ensure the smooth implementation of the course.

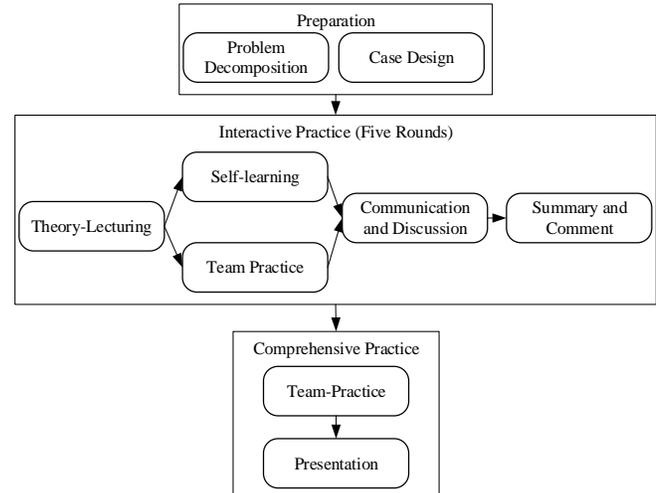


Fig. 1. Overall design solution

After that, in a full teaching cycle (usually 16 weeks), the six knowledge points are divided into two stages of practice and training. The first stage is divided into five rounds of interactive practical teaching units, in which the first five knowledge points are completed respectively. In the implementation process, each teaching unit consists of multiple inside and outside class hours. Different teaching methods discussed in the previous section are adopted according to disparate teaching objectives:

1) *Theory-Lecturing*: Led by teachers, introduce the basic theories and practical methods involved in each module systematically. The class hours of this part is not long, generally about 2 to 4 hours. There is no need to explain them in depth, such as in the requirement elicitation section, several typical elicitation methods would be introduced.

2) *Self-learning and Team Practice*: Led by students, students use the basic methods introduced in theory-lecturing, launch various forms extracurricular practice activities around the case, and apply theory and methods during practical activities to discover problems. Different forms for extracurricular practice can be adopted according to the objectives of each teaching unit, including but not limited to extracurricular investigation, document writing, model design, code development, etc.

3) *Communication and Discussion*: In the interactive link between teachers and students, based on the team practices in previous stages, students interact with teachers with problems in practice, so that they are able to understand the relevant concepts and methods in depth, and truly learn through practice. The interactive forms include, but are not limited to, classroom discussion, practice training, defense and so on.

4) *Summary and Comment*: Led by teachers, arrange a summary about 2 hours after each round of practice, summarize and comment on the results submitted by students, integrate with relevant theory knowledge points, analyze the existing typical problems, and deepen the comprehension and application of theories.

The second stage is a round comprehensive training, which is mainly used to complete the sixth knowledge point: system implementation. Students should synthetically apply various technical means in the team to implement the case. This stage is mainly led by students. Teachers participate as an expert, learn the progress regularly, exchange views for implementation details, and offer opinions and suggestions on the problems. After the practice is finished, teachers conduct centralized presentation, and the team's judgement of each other's realized cases. The appraisal standard at this stage is whether or not previous requirements and design schemes are followed, so that students can exactly understand the effect of requirements and design in system development, and truly possess the ability of software system analysis and design.

IV. ANALYSIS OF THE IMPLEMENTATION EFFECT

For the sake of learning the specific teaching effects, anonymous questionnaires were organized after the end of each academic year. The questionnaire survey comprises the mastery condition for basic knowledge points and concepts, the implementation effect for the interactive teaching mode and various interactive teaching methods. This paper mainly introduces the results of the latter two aspects related to interactive teaching. The survey data comes from 2018 and 2019 two semesters, a total of 195 students participated, including 85 students in 2018 and 110 students in 2019.

The results of the survey are shown in Table I, aiming at the problem of whether the interactive teaching model and the case are appropriate. As seen from the table, the majority consider that the course case meets the requirements of practical education (inappropriate for only 7%). Nearly 93% students believe that this interactive case driven teaching model is benefit for improving practice skills. Most of the major problems faced in practice are considered to arise from architectural design, and the two problems related to architecture design both account for more than 79%, which indicates that students generally attach more attention to technical problems; moreover, for undergraduates, architecture is exactly the most difficult.

TABLE I. THE IMPLEMENTATION EFFECT OF INTERACTIVE TEACHING MODE

Question	Option	2018		2019		Total Pct.
		Number	Pct.	Number	Pct.	
Do you think this case is appropriate for the course's practical teaching?	Appropriate	44	52%	57	52%	52%
	Basically appropriate	35	41%	44	40%	41%
	Inappropriate	6	7%	9	8%	7%
Do you think this interactive case driven teaching model is effective for improving practical skills	Yes	44	52%	57	52%	52%
	Perhaps	35	41%	46	42%	41%
	Not sure	6	7%	5	4%	6%
	No	0	0%	2	2%	1%
What do you think are the main problems faced in case practice (multiple choice)	Without real users, the requirement is not clear	52	61%	70	64%	63%
	Without experience for architecture design, unable to know how to design the architecture	61	72%	94	85%	79%
	The non-functional requirements of system performance and concurrent volume are not well comprehended and there is no ideal how to design them	54	64%	86	78%	72%
	Other	4	5%	3	3%	4%

TABLE II. THE RESULTS OF THE SURVEY ON INTERACTIVE TEACHING METHODS.

Interactive teaching methods	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	Average Ranking
Teacher's lecturing	52	40	37	30	21	15	2.86
Students' practice after class	58	63	25	25	17	7	2.49
Students' class defense and discussion	7	16	30	38	50	54	4.38
Students' communication and discussion with teacher inside/outside class	24	27	39	39	38	28	3.64
Teacher's explanation about completion of students' practice	38	35	35	40	29	18	3.21
Strict schedule control	16	14	29	23	40	73	4.42

Furthermore, we also conduct a survey on the recognition of various teaching approaches in the interactive teaching mode, which is a sorting problem that allows students to sort the approbatory degree for different teaching methods adopted for interactive education. Table II shows the survey result. The first column lists teaching methods, the middle six columns indicate the number of people who rank position of the corresponding teaching method (adding up two years' data), and the last column is the average ranking for each teaching method. As seen from the table, the ranking of these teaching methods is students' practice after class (rank: 2.49), teacher's lecturing (2.86), teacher's explanation about completion of student's practice (3.21), student's communication and discussion with teacher inside/outside class (3.64), student's class defense and discussion (4.38), strict schedule control (4.42). This result is a bit unexpected. Students still approve the two traditional teaching ways: practice after class and classroom instruction, while the two interactive teaching methods: explanation of practice and discussion with teacher, rank in the middle, with students' class defense and strict schedule control in last. After careful analysis, it is actually related to the current general learning state and learning style of college students. Most undergraduates have been accustomed to the learning mode that students listen to teachers in class and finish assignment after class, promoted by teachers, but lack of enthusiasm for manners like joining in discussions in class, keeping track of after-class practice, strict schedule management and so on, which require their own initiative of participation. For example, strict schedule control is significant in actual engineering. However, students have put this kind of teaching method at the end, and the phenomenon of student late with assignment is still widespread. This survey also reminds us that the implementation of this interactive case teaching way should be further improved, and better incentives should be considered to encourage students to participate in teaching activities initiatively so as to experience the cruelty of actual projects.

V. CONCLUSION

The interactive teaching mode is a flexible teaching way composed of a variety of different teaching methods. The mode may give full play to student's initiative. Students are able to learn from problems and practices through interaction with teachers, and other students, so as to truly grasp and understand the course. Based on the research of interactive teaching mode, this paper combines the interactive teaching practice taken in software system analysis and design course which was taught in the undergraduate's third year in software engineering major. The implementation result shows the interactive mode may improve teaching more effectively.

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