Application of BOPPPS Model in the Course of Embedded System Design

Xiaojun Guo, Shaojing Su, Zhiping Huang, and Chunwu Liu
College of Mechatronics and Automation, National University of Defense Technology, Changsha, China
Email: jeanakin@163.com

***Abstract*—Aiming at the problems such as the single teaching method and the lack of students' participation in the class teaching of embedded system design, and combining the characteristics and knowledge system of the course, the international frontier teaching concept BOPPPS teaching model is applied to the design of basic course of embedded system design. Through class introduction, writing learning goals, pre-assessment, participatory learning, post-assessment, class summary, the full content of the class is designed.**

***Index Terms*—BOPPPS, participation, embedded system design, student-centered**

I. Introduction

As a new and comprehensive interdisciplinary subject, embedded system involves many subjects, such as instrument science and technology, computer science and technology, control engineering, etc. The vast majority of domestic institutions regard embedded system design as a core course in their respective instrument science and technology professional training program, in order to enable students to complete the transformation from embedded system users to embedded system designers.

Embedded system design is a course combining theory and practice, the typical embedded instruments are adopted as the cases. The hardware and software architecture and the main modules of the embedded system are used to organize the content of the course. The course has many concepts, logical reasoning and strong practice. The traditional teaching model focuses on teaching and emphasizes the imparting of knowledge, in which the teacher is the professor of knowledge and plays a leading role in the teaching process. The theory of constructivism is centered on "learning", that is, student-centered, students play a leading role in the teaching process. In which teachers are the instructors, helpers and organizers of student learning. It highlights the students' subjective initiative, more likely to stimulate the enthusiasm and initiative of the students [1]. So, in the actual teaching process, how to organize all aspects of teaching, how to highlight the center of the students, to fully mobilize the enthusiasm of students is the key problems that require specific deeply research.

BOPPPS teaching model is a student-centered teaching model, which is based on constructivism and communicative approach, in recent years, it has been adopted by many well-known institutions in Canada. At present, BOPPPS teaching mode is usually used to train teachers' teaching skills [2], and the application of this model to practical teaching is relatively few.

Manuscript received December 21, 2017; revised March 7, 2018.

II. The BOPPPS Model

BOPPPS teaching model is a tool for teachers to organize class teaching. It focuses on the process of class teaching. The process of class teaching is divided into six components: bridge-in, objective or outcome, pre-assessment, participatory learning, post-assessment and summary [3].

The bridge-in is the introduction to the content of the study, the purpose is to attract interest of learners in learning; a variety of ways can be taken, such as the proposed challenging issues, through well-known cases. The objective is to clearly understand the goals to be achieved, focusing on the expression of the learning objectives.

The description of the learning objectives must be specific and observable or measurable. It is generally held that learning occurs in three broad domains-cognitive, psychomotor, and affective. These three domains of learning often overlap and many learning activities will fall into the overlapping areas. While much learning integrates all domains, in a mini-lesson there will usually be a primary focus on one particular domain, as shown in Fig. 1. Cognitive includes intellectual outcomes involving factors, theories, concepts, etc. Psychomotor includes new physical skills, performances, creation of products. Affective includes attitudes, values, beliefs, emotions.

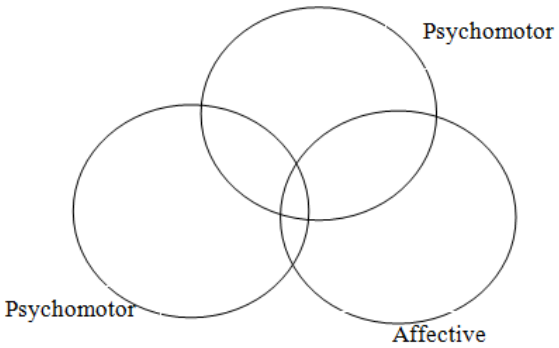

Figure 1. There learning domains.

A sample of action verbs, arranged alphabetically by levels and learning domains, is shown in Table I.

doi: 10.18178/ijlt.4.3.243-246

TABLE I. ACTION VERBS BY DOMAIN AND LEVEL OF LEARNING

Cognitive	
Novice	Cite name define outline identify select label specify list state match translate
Advanced Beginner	Apply explain convert illustrate discuss practice distinguish prepare draw use estimate summarize
Competent	Analyze explain compare modify contrast plan criticize predict diagram schedule discriminate
Experts	Assess formulate compose generate create organize critique propose design
Psychomotor	
Novice	Grasp pull hear push identify set up locate select move show press sort
Advanced Beginner	Adjust insert assemble locate copy loosen disconnect remove draw rotate fasten slide
Competent	Active manipulate calibrate measure construct operate duplicate perform fix trace load
Experts	Adapt diagnose combine generate compose organize design repair devise
Affective	
Novice	Accept name ask recognize describe respond to follow see identify select listen use
Advanced Beginner	Account for discuss accumulate follow assist perform choose practice commend share comply study
Competent	Approve join complete justify display propose form verify initiate work through invite
Experts	Adapt mediate defend organize design revise influence solve integrate

The pre-assessment is to test the learners' awareness of the content of the study before the specific content is learned, and the depth and progress of the class content can be adjusted according to it. The pre-assessment can be carried out by questioning, brainstorming and quiz. The best pre-assessment include open-ended question, that is, one cannot be answered with a simple “yes” or “no”. Open-ended questions allow learners to add experiences to the lesson and improve participation and learner engagement.

Participatory learning encourages learners to participate in the learning process, which focuses on making learners become the leading learners. There are two types of common participatory learning styles, namely, the interaction between teachers and learners, and the interaction between learners. The purpose of the post-assessment is to test the effect of the learner's learning and to check whether the learning goal is achieved. It can be carried out by small tests, short essays and scene analysis according to different situations.

The summary is to summarize the contents of the class, which can be conducted in a variety of ways, such as content review, class feedback, and affirmation of the learner's efforts and achievements. The BOPPPS teaching model highlights the importance of teaching links in class teaching, the participatory learning, that is, the dominant position of learners in the class, which is an important difference between the BOPPPS teaching model and the traditional teaching model. Therefore, in the actual teaching, it is necessary to organize the class teaching activities according to the characteristics of the course, especially to highlight the important role of participatory learning and to highlight the dominant position of learners [4].

III. CLASS DESIGN BASED ON BOPPPS MODEL

Based on the characteristics of the course embedded system design, the author, under the guidance of BOPPPS model [5], takes the contents of the analog-to-digital conversion and digital-to-analog conversion in the course as a case, makes some preliminary explorations and attempts in the class design according to the 6 stages of the BOPPPS model, which are listed below.

A. The Bridge-in of the Embedded System Design

The purpose of this phase is to attract students' attention and help students focus on the class content that is about to be introduced. For example, in explaining embedded systems overview, the example of the Appollo landing program navigation control computer can be introduced to facilitate students to understand that embedded systems nowhere, and it has been in the forefront of scientific exploration. In addition to the above-mentioned story about the subject of teaching, the bridge-in of the class can be carried out by providing the reasons, importance or commonness for the course, showing the full range of relevant topics through the audio and video information, and summarizing what has been learned and exporting the contents of the study.

The study curricula includes the basic courses and the specialized course, in which the basic course is used to enhance the students’ basic research ability, and provide the foundation for the specialized course teaching. The basic courses adopt the traditional school centralized teaching way. Specialized courses are implemented in the form of "research class" and " case discussion". Teaching team members are often in charge of latest researches, therefore they have a better understanding of the current situation of the students' technical ability and the engineering problems that need to be solved, and can arrange the course content according to the difference of the students.

B. The Objectives of the Embedded System Design

The purpose of this stage is to clearly convey the teaching objectives to the students, such as the key knowledge of the course, learning value, so that students have a clear grasp of the learning focus, usually the narrative of the goal needs to include, who is the object, what will be learned, under what condition and learning how well and other elements. What needs special attention is that the class goal must be student-oriented, and the aim is to inform students of the ability to gain after learning through the course. For example, for the analog-to-digital conversion principle class, there can be three learning goals "describing the definition of analog-to-digital conversion", "listing more than two kinds of analog-to-digital conversion method", "given analog-to-digital converter, calculating its resolution, precision, conversion time parameters". For the "digital-to-analog conversion" class, there are two goals "describing the process of the digital-to-analog conversion" and "given a digital-to-analog converter, calculating its T-type resistor decoding network." Through these clear objectives, the students are more likely to understand what should be achieved and how much they have achieved.

C. The Pre-assessment of the Embedded System Design

For the teaching class, because the content and the knowledge point involves a lot of definitions, the structure is complex, the practice is strong, and therefore the link of pre-assessment is very important. By the link of pre-assessment, the teacher can understand the students' familiarity with the teaching contents in the course of microcomputer principle, advanced language design, analog and digital circuit foundation. On the other hand, the teacher can understand the level of the students' mastery of the previous stage, and then the teachers can adjust the depth and progress of the class content according to the results of the class pre-assessment. For students, they can understand their deficiencies through the pre-assessment, and express to teachers the need for review or further explanation. Different class pre-assessment methods can be used in different class content, for example, for "the basic concept of analog-to-digital conversion" class, the "please describe the relationship between analog-to-digital conversion and data acquisition system" can be used as the pre-assessment. If the students do not meet the teaching requirements, the whole structure and key links of the data acquisition system can be review. For the "analog-to-digital conversion principles and indicators" class, the "what are the common metrics for analog-to-digital converters?" can be used as pre-assessment to understand the student's degree of familiarity with the principle of analog-to-digital conversion. For each class pre-assessment, the forms can be varied, and it can be done through class quizzes, informal questions, open-ended questions, brainstorming, and so on.

D. The Participatory Learning of the Embedded System Design

For different teaching content, there are many forms of participatory learning to improve students' interest in learning. Common practice is divided into two kinds, the first is the interaction between teachers and students, such as the introduction of "analog-to-digital conversion" concept, the teacher can ask students "the mainly application background of analog-to-digital conversion", let the students raise their hands to answer the question. The teacher can also send a note paper to students to write "several common application of analog-to-digital conversion" on the notes. The other is the interaction between students, this stage can take many forms, such as dividing the students into groups to discuss problems, or allowing students to work together to solve a problem, or to design a simulation scenario, to pull the class participants into an interactive context, or to ask questions from students, other students to throw out solutions and discuss and evaluate. For example, in the class of "principles of analog-to-digital conversion", students can be divided into 6 groups. Each group will discuss the advantages and disadvantages of the three typical methods of analog-to-digital conversion by understanding the case material. Then the group is regrouped according to the principle that the team members are grouped second times and not in one group. After grouping, the members of each group explain the advantages and disadvantages of the analog-to-digital conversion method, and the students learn the advantages and disadvantages of the 3 typical analog-to-digital conversion methods in group discussions and other peer explanations. It is worth noting that in the process of student interaction, teachers to carry out process control, and constantly understand the preparation of students, review the preparation of the content and guide students to analyze the problem, make the evaluation and analysis of each other, broaden the students' knowledge, deepen the understanding of the study, and improve the students' ability to find and solve problems.

E. Proposal and Dissertation the post-assessment of the Embedded System Design

Through this stage, the teacher can understand the effectiveness of the students and whether to achieve the teaching objectives, and assign the homework according to the results of post-assessment, and adjust the depth and progress of the next class. For different professors, there are different post-assessment methods. If the content of the class is the basic concept, the form of the test can be the gap filling, multiple choice or short answers. If the content of the class involves the structure and principle, the students can be asked to describe the basic steps of the implementation of the principle, or to realize the concrete implementation of one of the steps. The form of class post-assessment can also be diversified, which can be accomplished by class quizzes, informal questions and open-ended questions.

F. The summary of the Embedded System Design

Through this stage, the teacher summarizes the content of the class, integrates the main points of study and predicts the content of the next class, and lets the students prepare before class. Common forms of class summary include direct instruction, give students a summary form, or draw a summary picture on the blackboard.

IV. Conclusion

The practice shows that the class of embedded system design which designed according to the 6 stages of the above BOPPPS model can rapidly improve the students' learning initiative, fully arouse the students' interest in learning, and improve the teaching effect significantly.

Acknowledgment

The author wishes to thank Xiaopeng Tan, Shaojing Fu. This work was supported in part by a grant from Postgraduate College of National University of Defense Technology (yjsy2017022).

References

[1] W. Y. Ni, S. P. Chen, and Y. Zhang, “Computer network teaching case design based on constructivism,” *Journal of Changsha College*, vol. 27, pp. 125-126, September 2013.

[2] C. J. Tan, H. F. Zhou, Y. Liu, and L. L. Jia, “Instructional skills training based on Canada model,” *Computer Education*, vol. 4, pp. 47-50, December 2014.

[3] P. Pattison and D. Russell, *Instructional Skills Workshop (ISW) Handbook*, Vancouver: UBC Centre for Teaching and Academic Growth, May 2006, pp. 42-63.
[4] J. Allan, "Learning outcomes in higher education," *Studies in Higher Education*, vol. 1, pp. 93-108, January 1996.
[5] J. B. Johnson, *et al*., *Instructional Skills Workshop Handbook for Participants*, ISW Advisory Committee, October 2006.

Xiaojun Guo is born in Dec.14th of 1983 in Zhoukou, China. She graduated from National University of Defense Technology (NUDT) in 2013 with the Doctor of engineering in instrumentation science and technology, Changsha, China.
She is now a lecturer of NUDT. She is in charge of 3 courses: photoelectric detecting technology, embedded system implementation and application and digital testing technology. She has published 2 books: Digital Testing Technology (Beijing, China: National Defense Industry Press, 2014) and Experiments Instructions for Embedded System Implementation and Application (Changsha, China: National University of Defense Technology Press, 2015). Her research interests focus on simulation and credibility evaluation on autonomous underwater vehicle, Bayesian inference in test data analysis and applied cryptography in SDH digital transmission.

