Abstract—Computer organization and design course is one of the fundamental courses for computer science education. With the rapid progress in semi-conductor, new technologies in computer science are also emerging. It becomes more challenging for universities to design computer organization and design course. More new teaching methods and innovations are used to obtain better teaching effects as the corresponding responses to the continuous development of the research and technology. Though the experiences show that the teaching effects can be improved through the innovative teaching methods, how to evaluate the important factors of these methods accurately is still not clear. In this paper, we describe the methodology used by Zhejiang University to evaluate the teaching effects of teaching methods in computer organization and design course. Our methodology is based on the evaluation from the students. Such methodology can help the teachers find out the advantages and flaws of different teaching methods and then improve their work.

Keywords: evaluation methodology; computer organization and design; teaching method; teaching effect

I. INTRODUCTION

With the rapid progress in semi-conductor technology, new advances are emerging in computer science. More and more transistors are integrated onto a single chip and more powerful processors are designed and produced. CMP (Chip MultiProcessor) [1] and SoC (System on Chip) [2] are the typical new advances. Such developments in computer hardware and architecture mean that the theory and practice in computer organization and design course should also be updated. It becomes more challenging for universities to design their related courses. Different universities have adopted their own solutions to update the related courses according to their research and teaching background [3-5]. Improved and new teaching methods are also adopted to enhance the teaching effects.

How to improve the teaching in computer organization and design relies on not only the methods adopted, but also how to evaluate the teaching effects of these methods. The research in computer science education has proposed different methodologies [6-9]. These methodologies are good explorations in evaluation space. But it is not described clear in how to evaluate the teaching effects for computer organization and design courses.

In this paper, we describe the evaluation methodology used in computer organization and design course at Zhejiang University to evaluate the teaching effects of the teaching methods. First, we design nine evaluation aspects as the basic evaluation baseline. And then the students will submit their evaluations of the different aspects. At last the collected results will be recalculated and analyzed to find out the advantages and flaws in the teaching methods. The evaluations from the students can reflect the quality of the teaching effects of different teaching methods. Such methodology can help the teachers find out how to improve their work further.

The paper is organized as follows. Section 2 describes the basic course design in brief. Section 3 describes evaluation methodology and Section 4 shows the evaluation results and analysis. At last, Section 5 offers the conclusions and future work.

II. COURSE DESIGN

Computer organization is considered as the core course in CS2005 [10] and CSC 2008 [11]. The course at Zhejiang University is titled as “computer organization and design”. This course is always the obligatory course for the majors of college of computer science. We aim to teach the basic principles and skills on how to design and implement a computer system to the students. The contents of this course include: instruction set architecture and design, assembly language programming, computer arithmetic processing unit design, memory system design, input/output design and organization, pipeline design techniques, I/O system design, I/O Performance measurement. These contents are the theory teaching contents in class.

This course is a hardware based one and the students have to learn how to implement the computer through hands-on labs. We also design hands-on labs for this course by using FPGA [12]. These hands-on labs can be divided into two types: one is the basic hands-on labs and the other is the comprehensive hands-on labs. The former is to train the skills of the students in the basic implementation of the hardware components and the latter is to train the students to design and implement a whole computer system.
Our course has been selected as the MOE (Ministry of Education of China) – Intel elite course in 2008. And it is published to all the universities as the reference for the computer organization related course. We have adopted different teaching methods in this course. And each teacher in our teaching group also has his own characteristic in teaching. Though the teaching effects show that our course can obtain good performance, how to improve this course further is still our work. That is why we propose the evaluation methodology to evaluate the teaching effect of teaching methods in this course. In our opinions, the students will be the best judgments of the teaching effects, thus our methodology is also based on the evaluations from the students. In Section 3, we will describe our evaluation methodology in detail.

III. EVALUATION METHODOLOGY

This course is designed for the students and its target is to train the students. The students are the center of the course. And their evaluations will reflect the teaching effects directly. When we design the evaluation methodology, the students are taken as the center of this methodology. The evaluations from the students play the core role in our methodology. According to the experiences in this course, we have designed nine aspects as the baseline in evaluation methodology as shown in Table 1.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>A.1</td>
<td>Reasonable teaching arrangement, having outstanding keystone</td>
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<tr>
<td>A.2</td>
<td>Using reasonable teaching manner</td>
</tr>
<tr>
<td>A.3</td>
<td>Adopting heuristics, seminar learning</td>
</tr>
<tr>
<td>A.4</td>
<td>Focusing on knowledge using, having great gain after learning</td>
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<tr>
<td>A.5</td>
<td>Being satisfied with teacher's teaching attitude</td>
</tr>
<tr>
<td>A.6</td>
<td>Advanced, reasonable, substantial curriculum contents</td>
</tr>
<tr>
<td>A.7</td>
<td>Appropriate, good quality teaching material</td>
</tr>
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<td>A.8</td>
<td>Faultless, sufficient teaching information in course database</td>
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<tr>
<td>A.9</td>
<td>Being satisfied with the course or the teaching methods</td>
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</table>

Each aspect has five ranks. They are very satisfied, satisfied, neutral, unsatisfied and very unsatisfied. And each rank has a corresponding score: Rank. 1 (very satisfied → 5), Rank. 2 (satisfied → 4), Rank. 3 (neutral → 3), Rank.4 (unsatisfied → 2) and Rank 5 (very unsatisfied → 1). The students can give the score to each of these evaluation aspects. The evaluation of the students will be collected and calculated. The following definition and equations are used in the calculation.

**Definition 1.** Instant total score of a single evaluation aspect (ITSA(y)(a)) means the total score of the evaluations of a single evaluation aspect a in a certain year y. ITSA(y)(a) of year y can be calculated by (1):

\[
ITSA(y)(a) = \sum_{i=1}^{n} \text{Score}_{i,a}
\]  

Score\_a means the score of aspect a. a will be one of the aspects in table 1.

**Definition 2.** Average score of a single evaluation aspect (ASA(y)(a)) means the average score of the evaluations of a single evaluation aspect in a certain year. AS A(y)(a) of year y can be calculated by (2):

\[
ASA(y)(a) = \frac{\sum_{i=1}^{n} \text{Score}_{i,a}}{n}
\]

n is the number of students selecting this course in year y.

**Definition 3.** Weighted average score of a single evaluation aspect (WASA) means the weighted average score of the evaluations of a single evaluation aspect in m years. WAS can be calculated by (3):

\[
WASA(a) = \frac{\sum_{y=1}^{m} \sum_{i=1}^{n} \text{Score}_{i,a} \times S(y)}{\sum_{y=1}^{m} S(y)}
\]

Here\_S(y) is the number of the number of the students selecting this course in year y.

**Definition 4.** Instant total score (ITS) means the total score of the evaluations in a certain year. ITS of year y can be calculated by (4):

\[
ITS(y) = \sum_{i=1}^{n} \text{Score}_{i}
\]

Here y is the year and n is the number of the students selecting this course.

**Definition 5.** Average score (AS) means the average score of the evaluations in a certain year. AS of year y can be calculated by (5):

\[
AS(y) = \frac{ITS(y)}{n} = \frac{\sum_{i=1}^{n} \text{Score}_{i}}{n}
\]

**Definition 6.** Weighted average score (WAS) means the weighted average score of the evaluations of m years. WAS can be calculated by (6):

\[
WAS = \frac{\sum_{y=1}^{m} \sum_{i=1}^{n} \text{Score}_{i} \times S(y)}{\sum_{y=1}^{m} S(y)}
\]
Through the six equations, the evaluations of the teaching effects can be calculated. And according to the results, the teaching effects can be analyzed from different aspects of the evaluations. In Section 4, we will describe the evaluation results and analysis in detail.

IV. EVALUATION RESULTS AND ANALYSIS

A. Student Evaluation

We have designed and implemented an evaluation system based on the portal of this course. This system is a part of the portal. And it is open to all the students who have selected this course. These students can logon and do the evaluation online. And the submissions of the evaluations are anonymous to the teachers.

The evaluation data adopted for analysis is from year 2005 to year 2008 (these years will be shorted as 05, 06, 07, 08). There are three academic years according our data: 05–06, 06–07, 07–08. Each academic year spans two years. Table 2 presents the number of the students who have selected this course and submitted their evaluations in the three academic years.

<table>
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<th>05–06</th>
<th>06–07</th>
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<tr>
<td># of taking course</td>
<td>50</td>
<td>61</td>
<td>83</td>
</tr>
<tr>
<td># of submitting evaluation</td>
<td>45</td>
<td>51</td>
<td>77</td>
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</table>

In each academic year, there are more than 50 students selected this course and there are also approximate submissions of the evaluations. It can reflect that the students are willing to evaluate our course. And we can obtain enough data for our evaluation and analysis. Table 3 shows the detail of the students submitting their evaluations in the three academic years. And Table 4 shows the average aspect score and the average total score of this course.

B. Result Analysis

According to the student evaluations, we can analyze the teaching effects. Fig. 1 shows the students joined the evaluation in the three academic years.

![Figure 1](image-url)  
Figure 1. The students joined the evaluation in the three academic years

As we can see from Fig. 1, the absolute number of the students selecting this course and joining the evaluations is increased. Though the rate (number of the students joining the evaluations/number of the students selecting this course) decreases in 06–07, the rate is also increased in the next year (07–08). More and more students select our course and more and more students join our evaluation. The increased number of the students can help us evaluate the teaching effects of our course.

Fig. 2 is the curve of the scores of the nine aspects and the whole course. As shown in Fig. 2, the scores of eight aspects and the total average are increased during the three academic years. It means that most of our teaching methods
can improve the teaching effects and obtain the students’ reorganization. Only A.9 aspect decreases in 07-08. It means that we should improve the special teaching methods in our class.

![Graph showing scores of nine aspects and the whole course.]

Figure 2. The curve of the scores of the nine aspects and the whole course.

But from the analysis of the results, we can also find some flaws in our course. Table 5 is a transformed result of AWSA. For each year, the results of each aspect is set by 0 if the weighted average score of criterion is bigger than the average score of the course, or else the result is set by 1. Column 5 is the sum from column 2 to 4. From the sum, we can see score of aspect A.8 is smaller than average every year, aspect A.3 and A.7 are also not satisfied well. Just aspect A.4, A.5 and A.6 are always bigger than average. This illustrates that the teaching information database is the weakest part in our course, and heuristics learning and teaching materials should be improved.

<table>
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<th>TABLE V. WEEK ASPECTS IN OUR COURSE.</th>
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<td>A.1</td>
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V. CONCLUSIONS AND FUTURE WORK

Computer organization and design course is the core course in computer science education. The evaluation of the teaching effects is also very important to teach the theory and skills to the students. In this paper, we describe our evaluation methodology for teaching effect of teaching methods in computer organization and design course at Zhejiang University. Our methodology is based on the evaluations from the students who select this course. The evaluation results show that we can find out the advantages and flaws of different teaching methods and the course with the help of such methodology.

We still want to solve the problems in the result analysis. And there is another special problem: how to map the single method to the methodology for the detail evaluation of this method. They are all our future work.

REFERENCES