# Using Undergraduates as Teaching Assistants at Harbin Institute of Technology

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Abstract: For many years the programming courses in Harbin Institute of Technology are so inefficient that many students can't write programs efficiently, ever though they have got high grades. One of the reasons is that we are lack of instructional supporting, so that our students can't get necessary help timely. Using undergraduates, who are good at programming, as teaching assistants not only deal with the problem, but also help the undergraduates themselves doing better. And it brings an efficient way for teaching of the courses.

**Keyword:** undergraduates, teaching assistants, course, programming, students

## 1. Introduction

This program began in 2008 when we developed ACM ICPC(ACM International Collegiate Programming Contest) in Harbin Institute of Technology. In 2008 we were designated to hold a post of coach of HIT ACM ICPC. The first task we faced was how to get higher prize in regional and how to develop the contest all over our institute. What we have done firstly was to introduce the contest into the relative courses, such as C programming language. We integrated the contest problems and concepts into the course as the part of itself, and guided the fresh students to do contest problems as exercise and homework.

But it was not enough. We should get touch of these fresh students more often and more close. How to do? By analyzing all process of the course, we found the breach on teaching assistant (TA). For an example, in the course of 13SD03100300 which is opened in fall for fresh students, all teaching assistants were undertaken by graduates. As teaching assistants, they should contact often with the fresh students to give their support face-to-face and step by step every week or every day. But their performance was not so good. With the license of our dean, We tried to replace half of teaching assistants in course 13SD03100300 (High Language Programming) with our undergraduate students who had more than two years of experience on ACM ICPC. It was so successful that in next year all teaching assistants were undertook by these undergraduates. And then we expanded this program to other courses, such as 13SD03000510(C Language Programming), 08N1031010 (Formal Languages and Automata), 08T1031050(Operating System), etc.

This program not only made the ACM ICPC known well among the students but also help us to find a way for teaching and learning. Maybe it is more important for us to get our courses more efficient.

# 2. Related Courses

#### (1) List of Courses

We apply the program in following courses. These courses are almost opened at the first or second semester for first year students.

• 13SD03100300, High Language Programming, is set up for computer major students at their first semester. It is an obligatory course for Computer major students. There are about 260 new students in our School of Computer Science and Technology every year.

• 13SD37000200, High Language Programing, is set up for software engineering major students at their first semester. It is an obligatory course for software engineering major students. There are about 160 new students in our Software Engineering Department every year.

• 13SD03000510, C Language Programming, is set up for all major students at their second semester, except computer major, software engineering major, and architecture major. It is an obligatory course for all students for which it is opened. Every year there are about 3000 students who register this course. • C000300500, Primary Programming Practice, is set up for all students who have programming experience ever. There are about 200 students to register this course every year.

#### (2) Instructional Support of Courses.

In a long term, it is a big crux that there is almost no any instructional support in courses, especially in these programming courses. In 2005, Graduate School in HIT implemented a program that every scholarship graduates must experience teaching assistant work at least once during their first year. At the same time, they made a restriction on the number of teaching assistants in each course. The situation of the instructional support of courses is shown as table 1.

Course	Major	Number of students	Number of TAs
13SD03100300	Computer Science and	240	16
High Language Programming	Technology	240	10
13SD37000200	Software Engineering	190	4
High Language Programming	Software Engineering	180	
13SD03000510	Company 1/most CS_SE)	3000	40
C Language Programming	General(not CS, SE)		

Table 1 Number of TAs in Courses in 2007

Before 2007 the number of teaching assistants in course 13SD03100300 is also 4. In order to strengthen the support of programming course, CS department deploy more graduates that 1 graduate correspond 15 students. Only this course can break through the restriction with the license of Graduate School.

#### 3. Selecting Teaching Assistants

Up to now, almost all teaching assistants are chosen from the contestants of ICPC. There are many kind of programming contests for our undergraduates to take part in which is titled with ACM ICPC. From the highest level to the lowest, the list of these contests is shown as bellow.

• Annual ACM International Collegiate Programming Contest World Finals. It is held in spring once a year. Almost all teams(contestants) are chosen from every regional who is among the best ones at programming in their school, their university, their country and their continent.

• Regionals. It is held in the autumn once a year before the World Finals. It is partitioned into 6 regions, such as Africa and the Middle East, Asia, Europe, Latin America, North America and South Pacific. There are several sites or more in each region. For example, there are 15 sites in Asia(5 sites in China).

• Provincial Programming Contest. There are about 20 provincial programming contests held in the spring in China every year. In each contest there are about 160

teams(3 contestants/team) competing with each other at a hall.

• University Programming Contest. In China there are many university programming contests held once or twice every year. We hold our university programming contest twice a year. About 500 students including few graduates take part in the contests each year. Most of them are first-year undergraduates. Some of them are second-year undergraduates.

There are about 50 contestants chosen from our university contest to take part in higher level contests, such as Heilongjiang Provincial Programming Contest, Northeast(China) Programming Contest and Asia Regionals. They got at least Bronze Medal on these contests.

For course 13SD03100300 and 13SD37000200, we assign one teaching assistant for about 15 students. So we need 18(260/15) and 11(160/15) TAs for these two courses. It is enough for us to select the suitable candidates from the above good contestants.

For course 13SD03000510, we need about 200 teaching assistants meanwhile. Surely we can choose these teaching assistants from the contestants of our university programming contest. But we don't expand the program all over the course. We have started the program in small scale including about 600 students. It is just an experiment for us to get supporting data by which we can convince our administrators.

# 4. Training Teaching Assistants

As a teaching assistant, he should meet the following qualities.

• Be good at programming. That means he knows algorithms well so that he can quickly find out the best algorithm to deal with the problem. And he is good at coding so that he can write the programs fast and efficiently.

• Be responsible. Though we pay reward for his work, it is very important for him to do as better as he can.

• Be familiar with teaching skills. Maybe they are very skilled at programming, but the fresh students are not. What they should do is make these fresh students do as better as they do. It is necessary for them to learn about some teaching skills, such as how to express, how to grade, etc.

There is a great difference between our program and what the conferences describe. Many of our students are weak at programming even though they got high grade of the course. So we must pay more attention to the programming capability of our teaching assistants at first. We train them mainly by holding programming contests and seminars described as bellow.

• Weekly programming contest. Students have improved their programming skills when they take part in the ACM ICPC. We hold online contest once a week almost all over semester to train students step by step. It is operated by 3-year or 4-year undergraduates who have at least two year experience of ACM ICPC. In another words they are also teaching assistants. They run the contests all by themselves, such as determining problems and Q&A online.

• Weekly seminar. The seminar is held after each online contest and hosted by our higher contestants also, working as teaching assistants. They play the role of lectures, giving short explain about the problems, responding the question of the students and discussing with them.

• Summer training. We hold summer training every year from the first day to last day of summer holiday. Yes, all students who taking part in summer training can't enjoy their summer holiday. There are about 70 students at beginning, and about 50 students remaining at end. We design the training schedule and use the 'old contestants' as teaching assistants who have outstanding performance in programming. These teaching assistants take over 80 percent of training work.

The whole summer training continues for 5 or 6 weeks all over the summer holiday. We work 6 days each week from Monday to Saturday. Every morning we give a lecture of algorithms introduction. After noon we do exercises or hold a contest. In evening we review and discuss the algorithms and problems. Lecturer takes the work of algorithm introduction on morning. And teaching assistants play the role of exercises/contests and discussion. They also take some work of morning lecture. The first week schedule is shown in table 2.

	Morning	Afternoon	Evening
Monday	Data structure	Exercises:	Review
	Stack/queue/tree	Dichotomy	
Tuesday	Greedy algorithm	Contest 12:00-17:00	Discussion 18:30-21:00
	Maximum/minimum heap	Greedy algorithm	Contest problems
Wednesday	Introduction :	Contest 12:00-17:00	Discussion 18:30-21:00
	Standard template library	Complex	Contest problems
Thursday	Dynamic programming	Exercise :	Review & discussion
	Basic	Problems/acm.hit.edu.cn	
Friday	DP:	Contest 12:00-17:00	Discussion:
	Monotonous queue	DP	Problem solving report
Saturday	DP:	Exercise :	Discussion :
	Memory search	Test & problems	Conclusion of DP
Sunday	Rest	Rest	Rest

Table 2 First Week Schedule

# 5. Using Teaching Assistants

In this paper we describe the work of our teaching assistants program by taking the course 13SD03100300 as an example. The situation on course 13SD37000200 and 13SD03000510 is very similar besides (6).

(1) Structure. All students are divided into two

Group 1 Number of TA: 4 Students: 60 Class 1 Instruct/Grade/Q&A Leader : A Students: 137 Group 2 Lecturer : Wang Number of TA: 5 13SD03100300 Students: 77 Instruct/Grade/Q&A Leader : B **High Language** Programming Group 3 Number of TA: 6 Students: 280 Students: 87 Instruct/Grade/Q&A Class 2 Leader : C Students: 143 Group 4 Number of TA: 4 Lecturer : Zhang Students : 56 Instruct/Grade/Q&A Leader : D

Table 3 Teaching Structure of Course

(2) *Instruction*. The total teaching hour of course is 48 hours, including 30 lecture hours and 18 coding hours. Teaching assistants don't need attend the lecture. The lecturer is in charge of all lectures. Teaching assistants are responsible for all coding instruction. They spend three hours every week on instructing students to write and debug programs. At this point all TAs in the same group work together for the same group of students. They go around in the class room, to answer the questions, to inquire about if someone gets in trouble.

At beginning they meet many problems and heavy work. The fresh students even don't know how to play keyboard. Someone plays keyboard with only two fingers - two forefingers. Teaching assistants must correct these bad habits at first and set a good example for them to imitate. Most of students don't know how to debug program – no idea how to find errors and correct them. Teaching assistants guide them debug their programs step by step.

(3) *Homework & Project.* There are five homework and two projects waiting for teaching assistants to review and check. Each teaching assistant is responsible for about fifteen students. They review the homework, checking whether correct and whether suspecting plagiarism, finally grading. At first two times they write more detailed reviews, later they just give a rough comment. It takes them about 6 hours at average on this work.

classes which belong to two lecturers. All students in same

class attend the same lecture of the same lecturer. Each

class is divided into two groups of which all students are

instructed by the same group of TA. The specific

description is shown as table 3.

It takes them much time to review the projects. They check the projects by discussing with every student. With the submitted materials they propose questions for student to answer. Sometimes they delete several lines from the program to check whether the student really write the program by himself. During this time they spend two hours at average to talk about with one student every day.

(4) Online Q&A. Teaching assistants are responsible for online Q&A. Each group assign to a person on duty every day. Maybe someone likes to stroll online and do the work on the way. This is a relatively easy work.

(5) *Grading*. It is a very challenging work for our teaching assistants. Though the criteria are very clear, there is much difficulty on implementation. We can't get the exact value of a program by putting it on a weight scale. So they put all students' work together for comparison with each other and finally give a relative grading. They write a grading report meanwhile for replying complaints of students later.

(6) *Mentoring*. We assign an additional task to all teaching assistants – to be mentor of the freshmen. Each teaching assistant is responsible for about 15 students.

According to the schedule, he should know of every one of his 15 students at first week, get separate conversation with each one before third week, inquiry and write abbreviated record of them every week. After the end of the course every teaching assistant submit a summary report including the record of his students.

(7) *Lecturing.* We make a further attempt in the course C000300500. The course hour is 30 and all is coding hour. That is, we bring our students talking about algorithms and writing programs in classroom with one computer per student. Firstly, we propose a real problem. Secondly, we talk about the algorithm suitable for the problem. Finally, we write the program to deal with the problem. Most of the problems are chosen from ACM ICPC online judge. Our contestants are very familiar with these kind of work. So we let them play the role of lecturer in this course.

#### 4. Advantage

Just like the program mentioned in the conferences, using undergraduates as teaching assistants has many advantages. We agree with the description of the conferences. Because of different situation, it has special meanings in Harbin Institute of Technology.

• Undergraduates are more efficient than graduates. These undergraduates are chosen from our ACM ICPC contestants who have experienced at least Provincial Programming Contest. They are good at algorithms and programming. Most of them are third year or two year undergraduates. What happened in their fresh time is still vivid in their memory. They are easier to deal with the the problems the fresh students faced. They are so familiar with the course that they can find out problem at a glance without waiting for the students asking them.

• Undergraduates are more responsible for the work. For most of them this is their first job in their lives, even though with a little salary. It is interesting enough to make them excited. We have really felt it from their wonderful performance.

• Using undergraduates as teaching assistants establish a community of undergraduates in different grade and different school. It is very helpful for them. In our university, all one year undergraduates are living another campus apart. At their first year they have seldom chance to touch and exchange with the seniors. In the program meet their tutors every week and often discuss with them. It is going to continue after the course end and loop next year.

• Undergraduates have improved themselves greatly by this program. They not only developed programming skills, but also developed many skills such as expressing skills, exchanging skills, understanding, communicating and so on. Especially, they have got considerable progress in lecturing. One of our students suffering from stuttering disorder, after playing the role of teaching assistant two times in the course C000300500, he can give a very fluent presentation now.

• Using undergraduates as teaching assistants have improved programming of our students greatly. Before we start the program, many lecturers who take follow-up courses complained that they can't exchange with students because of their poor programming. Now they say that they can talk about the courses deeply with students.

## 5. Conclusion

When we start to use undergraduates as teaching assistants, we didn't understand that we can get so great benefit. Through this program, we not only have developed ACM ICPC in our university, but also have made our programming courses more efficient. The most important is that we get a new style of teaching.

What we want to do in future is to develop the program in all programming courses, especially in 13SD03000510, C Language Programming. It is a big challenge for us to choose 200 graduates as teaching assistants.

### References

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