Different Teaching Methods for Program Design and Algorithmic Language

Yue Zhao, and Jianping Li

Abstract—This paper covers the present situation and problem of experimental teaching of mathematics specialty in recent years, puts forward and demonstrates experimental teaching methods for different education. From the aspects of content and experimental teaching approach, uses as an example the course "Experiment for Program Designing & Algorithmic Language" and discusses teaching practice and laboratory course work. In addition a series of successful methods and measures are introduced in experimental teaching.

Keywords—Differentiated teaching, experimental teaching, program design and algorithmic language, teaching method.

I. INTRODUCTION

IN China, almost all institutions of higher education offer experimental courses in mathematics speciality, to maintain and strengthen teaching theory, improve mastery of basic concepts and theoretical knowledge and train students' basal professional skills. The experiments have been focused more on application of mathematics (mathematical modeling and simulation), numerical calculation, and non-numerical calculation, application of computer and software and computing platform. These requirements are very important for cultivation of basic specialized skill, all-directional development of theory and practice. They also help the students majoring in mathematics to learn skills, improve competitiveness and more importantly form students' ideas of innovation and spirit of science [1]. However, in recent years some changes have taken place with students in their learning requirement, attitude and effect and also reflected in laboratory class. This is most obvious in local colleges and universities, which copy experimental finding and report less quality of experimental teaching. In its pedagogical perspective, learning is the object of requirement, and the subject of attitude, but effects show the combination of the subjective and objective reasons directly. We should analyze the problem and its causes in experiment class, cater to the students' mentality, develop viable approach of experimental teaching to assure that there are improvements in experimental teaching quantity at colleges and university.

Take, for example, "Experiment for Program Design and Algorithmic Language" a major and basic course in undergraduate degree of mathematics. As a complementary

Yue Zhao (Corresponding author) is with the School of Mathematics and Statistics, Yunnan University, Kunming, 650091, China (phone: +86-871-5033700; fax: +86-871-5033700; e-mail: zhao6685@ yahoo.com.cn).
Jianping Li is with the School of Mathematics and Statistics, Yunnan University, Kunming, 650091, China (e-mail: jianping@ynu.edu.cn).

course for the implementation of "Program Design and Algorithmic Language", one of the purposes is to cultivate students' abilities to arrange, store, process data and train its algorithm design, and it plays a role in the succeeding course of study. On the premise of understanding elementary knowledge, skill and method, the experiment asks the students to program to implement their algorithms with a particular programming language (C/C++/Java). For the purpose is training of programming and improving operating, especially for nonlinear data structure and nonnumeric algorithm, the understanding of algorithm design ability is crucially important [1-2]. The question, which the "Experiment for Program Design and Algorithmic Language" course answers, is representative for all experiment courses in mathematics speciality. Based on reviewing the status and analyzing the problems, probe into the teaching methods and measures suitable for the current situation to play a favorable instruction role in experiment courses in mathematics speciality.

II. PROBLEM AND ANALYSIS IN EXPERIMENTAL TEACHING

We analyzed and studied the present condition of Experiment for Program Design and Algorithmic Language, in regard to students' requirements, attitudes and effects in experimental course. The students can generally be divided into four main groups and each group has the following characteristics [3-5]:

A. Students with clear requirement, right attitude and remarkable effect account for about 30 percent (Table I). This group of students has fewer questions and much interest in experimental course work. They are able to accomplish the experimental task under self-knowledge and basic independence, so attained results give fresh impetus to their learning, and form a positive cycle. Students demonstrate initiative, motivation, with deep desires to learn additional and innovative subjects in experiment.

B. Students with clear requirement, right attitude, but backward effect account for about 25 percent (Table I). The common features are that it's easy to listen and difficult to do. That is, content of theory course can be understood, but there are many problems in solving the problems by themselves, especially in programming realization. Why? Experiment has definite practical applications, and requires the application of concept and content of course theory to complete programming and debugging, which is difficult and requires certain skills. Questions exist on all stages of basic concepts, algorithm design, programming realization and debugging programs. Questions that link up practicing and grasping, so their effects

do not match their expectation in experiment. These students can with periodic repetition grasp methods and skills.

C. Students with clear requirement, swaying attitude and general effect account for about 25 percent. There are many problems in their experiments, of which foundation is relatively poor, and particularly the language problems are the main sticking point in experiment. There is no source program for this in the mainstream textbooks with the close relationship between experiment and language course, and the algorithms with Class C and other pseudocodes. The students first encounter a variety of language-related technical hurdles in experiment and then fundamental problems from understanding of the experimental content, using theoretical knowledge, etc. They are up against the question B because the question of superposition causes difficulties in experiment for them. They form psychological barrier to learning attitude, as a result, hinder effective learning.

D. Students with unclear requirement, negative attitude, and poor effect account for about 20 percent (Table I). For various reasons, such as the change of studying environment in university, the fear of difficult learning, poor self-control and study habits their academic goals are vague. They have no active incentive for learning the subject. There are more varied problems in study (compared to B and C). Interdependence and increasing of the experimental content itself make their experimental problems pile up, dual negative influence of psychology and action decrease learning confidence and create "problem students".

Final behavior of the last three groups in the experimental program is problematic, so quality and effect are greatly influenced in the course. We discuss how to carry out Different Teaching, set teaching measure and teaching content in this paper, considering all types of students and the teaching experience of many years.

III. DIFFERENTIATED TEACHING OFF EXPERIMENTAL PROBLEM

Differentiated Teaching — education in accordance with individual differences means teacher's teaching is to proceed from actual conditions and individual difference. Differentiated teaching method is invoked in term of a definite object view. The teacher has purposes, plans or organizations to lead students to learn actively and conscientiously and measures shall be taken to rapidly improve their particular talents so that every student promotes advantages and abolishes disadvantages and strives for the optimal development pattern. Differentiated teaching methods and measures are adopted which suit one's methods to the situation in experimental teaching, and should solve problems by supplying a fine prescription.

The above analyses features and problems of the four groups in experimental course. The first three groups have many things in common: clear requirement, mostly right attitude. This will guarantee an advantage in the quality of experimental teaching. Teachers should grasp the subjective and objective positive factor to give positive guidance. For A group, students'

enthusiasm and effect should be encouraged and protected in learning to build a good experiment atmosphere. If their independent and assiduous mind is better stimulated in experiment, the influence will be able to help the whole group of students to expand learning enthusiasm. Students of general and poor ability account for a large percentage. We should create a series of effective differentiated teaching methods that aim to effectively guide and improve the ability to analyze and solve experimental problems, and help students develop their interest and motivation. This will play an important role in promoting the effect of experimental teaching. "Problem students" can not be avoided and teachers will face them under the large umbrella of expanded university enrollment. This is a problem deserving of study, how to energize problem students to study harder, improve "learner autonomy" and change the situation.

IV. EXPLORATION AND PRACTICE OF DIFFERENTIATED TEACHING METHODS IN EXPERIMENT

Fundamentally, the teaching quality not only depends on the scholarly level of teachers, but also depends on the level of the teaching methods. From the standpoint of experiment, the teaching method becomes much more critical for students. A series of good experimental teaching methods will help many more students solve questions themselves during the execution of experiments. The results improve students' practical ability, cultivate the students' subjective consciousness and explore the confidence of autonomous learning. Help each group to develop their potentials to good effect for themselves. Adopting the differentiated method should put emphasis on students during experimental teaching, not only must all the students be provided with uniform requirements according to teaching objectives, but the different measures also be used to correspond to the students of different levels. The teaching process must be carefully planed, and various parts of experiment should be properly arranged. It is necessary for content and measure to readjust and restructure so that it conforms to the practical possibilities of different levels of students [3-12]. According to the rich teaching experiences of many years, we have carried out some referential methods as follows.

A. The precondition of Differentiated Teaching

The teacher first must understand and distinguish his students, and need to prepare his students in order to prepare the lessons. The teacher may select through practice and testing to know the students ability from prior periods (language, for example). There are pertinent experiments to know students' capability of solving practical problems, attention should be paid to collect information to analyze and classify their studies (such as homework, testing, experimental coaching, experimental conclusion, classroom answering, etc). The teacher's responsibility and accumulated teaching experience should not be overlooked either [7-17].

B. For Easy listening and Difficult Doing

Attention should be given to learning of algorithms and methods about experiment in teaching theories. It is essential to conduct and prompt the important or difficult problem from algorithm description to program implementation, the organizational problem on storage, the algorithmic problem on experiment, etc. The lecture is also essential in experimental lesson. It should be pertinent, in the case of selecting the relevant programming methods, skills of algorithm design, and language problems. Based on tutorial in experiment, marking reports and past teaching experience use typical, common mistakes and questions as an opportunity to explain, analyze and discuss.

C. For Needed Pre-basic Problem of Experiment

Many students proceed from simple program language course to more complex program of algorithm course, but the integration problems from algorithm description to language programming is interruptive and unsmooth. The teacher is able to help and encourage them to take a quantum leap, but he cannot or should not monopolize language problem during experiment. Not only should the teacher first give the review topics and key points, but the student must also do in-depth revision for the language content in advance, and then let A group be language assistant to help to solve the language problem in experiment. Practice proves that this idea is a win-win for the group, which not only extends the A group's effect but also effectively solves other students' problems by mutual help and communication (Table. I).

TABLE I
THE DISTRIBUTION OF STUDENTS ACCORDING TO STUDENTS' REQUIREMENTS, ATTITUDES AND EFFECTS

Group	Before experimental reform	After experimental reform
A	30%	36%
B	25%	28%
C	25%	14%
D	20%	12%

D. Different Levels of Coaching with Differentiated Teaching

Tutorial is an important teaching method in experiment. Using tutorial promotes knowing students' individually and effectively helps them to solve various problems, It is a rather good method for teachers facing more students after high school to take different levels of coaching. If using language assistant solves the problem of language level in experiment, the teacher could concentrate on different levels of tutorial in algorithm and programming. For B group, the teacher should use enlightening discussion to guide to the student, which can point out the basic concept, discusses algorithm and approach in experiment, so as to encourage teaching interactivity and guide them gradually to learn and solve the problem during experiment process. For C group, on the basis of improving language, the teacher should help them to solve algorithm and program design, and may patiently explain when facing problems. When guiding C group to effectively clear the problem and see result in experiment, the learning could be stimulated and confidence of solving problems could be created.

E. The Study of Solving the Problem for D Group

Their experimental requirements are first focused on fundamental problems and then encourage them to think of additional exercises. Also, the teacher should discriminate between the poor attitude and the ability in solving problem. For the attitude problem, use stringent requirements to create limits rather than indulging the accumulation of unfinished experiment. Let them be reborn to accommodate the stringent requirements of course as soon as possible. Emphasis on experiment should stipulate the experimental term of validity, check on experiment attendance strictly, oversee the experimental results, evaluate the experimental report strictly, etc. The experiment shows that the stringent requirements enable them to alter their passive psychology and cause their positive effects. For student's ability or attitude in solving problem, use combined team, the good with the bad, co-operating experiment, different experimental report, and match reasonable examine evaluation. Cooperative and game mechanism is introduced to restrict copying within a group into grading. Using postgraduate's intervention in experimental learning is like increasing the proportion of A group. They concentrate on helping to solve experimental problems. In additional, extracurricular expanded materials, which the teacher prepares, can effectively help them in experiment, in which they are asked seriously to read and think the raised-problem with the problem, and make a replica of a program. Finally, they will be gradually guided to learn programming by themselves.

F. Using Experimental Summary Improve Student's Accumulation of Consciousness

Programming and debugging are a training and accumulation process. It is inevitable that student should face problems. And, solving problem, experiencing difficulty and detour reflect the growth and increase of student ability in experiment. The harvest and understanding of various students is different in experiment. It will urge student to seriously summarize and record into experimental report the problems arising, measure solving and create insight as harvest accumulates during experiment. His own abilities can be found and trained, which provide a background for teacher to examine and evaluate leading to later experiment.

In practice, differentiated teaching methods like above which propose various pertinent experimental problems have positive accelerative effects on the training of programming ability and improve operating ability. Most of the students are being reached and find their maximum effect in experimental course. Under heavy conditions of teacher's task, it is a fine proscription to ensure and improve the teaching quality in experiment for the current period.

V. EXPERIMENTS DIFFERENTIATED SETTING OF THE EXPERIMENTAL GOAL AND CONTENT

We think that the goal setting of experimental teaching should focus on consolidating and reinforcing the teaching effect of theory in mathematics specialty, and upgrade student's synthetical ability in his study as the embodiment of differentiated setting. Experimental goals could be fundamental, advanced (depending on of students' differences, improve their ability of synthetical application and solving problem), and transcendental (develops the capabilities of each student to offer a challenge). The design of experimental content corresponding to the above it could be divided into three categories: fundamental, additional and innovative. Fundamental proposition will have to be done to achieve fundamental objective of the course suitable for all groups of students. Additional proposition is optional questions which help student to get more studied expanded space suitable for the first three groups of students. Innovative proposition is to cultivate the spirit of student's scientific research and innovation awareness generally for A group.

For example, take Experiment for Program Designing & Algorithmic Language. There should be replication, design and comprehensiveness problems in the form of fundamental proposition, where the arrangement of the contents should consider generalization such as dealing with the establishment of the basic data structure and synthesizing the algorithm of several problems for solving. Synthesis of this type should not only be operational to all students, but also accord with the basic objective of training and improving their comprehensive ability. Second, emphasis on programming (or practical, or new student, or more complex) of dynamic memory, linked list, mixed memory and other storage structure, this may train student's ability of comprehensive programming using the various physical structures. In order to reflect differentiated teaching, the first experiments should include more replication. This can add individual experiment of sequential storage structure so as to let C and D groups gradually to deepen the learning process. The last experiments train student's ability of various logical structures and algorithm designs chiefly through the design problems.

Additional proposition may be expanded on fundamental proposition, such as giving the problem of practical application to design algorithm and program based on synthetical theory. This kind of synthesis is more comprehensive and difficult than that of fundamental proposition. It is necessary to train student's ability of application and problem solving and raise the professional comprehensive qualities of student. This kind of proposition is part of design type, it is very beneficial to inspire student's learning potential and cultivate his enquiring mind and innovation awareness. In practice, the student's achievement is greater through these kinds of problems. In addition, they could also extend sub-problem to increase the demand of sub-problem, so that B and C groups also get a necessary expansive learning to feel an existence of sublimation during finishing additional problems and improve their learning interest and positivity.

The proposition of designing innovative experimentation is to represent differentiated teaching and encourage scientific research spirit of excellent students. Meet the challenge in this kind of proposition and inspire innovation awareness through further thinking [4]. The innovation in experiment is relative. Strictly speaking, it is quite difficult to strive for a breakthrough in Linear, Tree and Graph data structures. The applications from the different problems are usually for creative development in computing and operation (its nature is algorithm) that emphasize on whether and how changes in algorithm lead to some changes in data structure. Experiment for Program Designing & Algorithmic Language has a foundational role and directly affects the successor courses. To motivate the students' interests of learning, help them contact successor problems earlier in professional courses and deepen their understanding of the importance of this course. The teacher may choose the data structures and algorithmic problems of non-numerical calculation type in successor courses as the source of student's problems in innovative experiment. Later turn these problems on the basis of algorithm into application problems of Program Designing & Algorithmic Language.

VI. CONCLUSION

In China, higher education has quickly realized the transformation from elite education to popular education. We are rethinking and studying the connotation of quality of popularized higher education, establishing the new educational concepts with the popularization of higher education, exploring the differentiated personnel training model, strengthening teaching practice, and improving student's ability of practice and innovation. The institutions of higher learning are able to achieve sustainable development. Implementing our differentiated teaching for experiment course in mathematics specialty is consistent with the idea of higher education, but is also very effective in practice.

REFERENCES

[1] Lu Y., "Thinking about teaching method of data structures and algorithms", *Computer Education*, vol. 13, no. 5, pp. 88-90, May. 2010.
[2] Tao Y., Zhang B., "Regarding to cultivate arithmetic design & analysis ability in data structure experimental teaching", *Research and Exploration in Laboratory*, vol. 27, no. 12, pp. 119-112, Dec. 2008.

[3]   Zhang G.F., Li H. B., "The reformation and exploration of data structure experiment teaching", *Higher Education Forum*, vol. 10, no. 6, pp. 103-104, Jun. 2008.

[4]   LI X. M., Zhuang W., et al., "Reformation and exploration of data structure experiment teaching for undergraduates of computer specialty." *Laboratory Science*, vol.10, no. 2, pp. 106-107, Feb. 2009.

[5]   Jafar M. J., Anderson R., Russell Anderson, "Software academic initiatives: A framework for supporting a contemporary information systems academic curriculum", *Journal of Information Systems Education*, vol. 55, no. 6, pp. 1-13, Jun. 2008.

[6]   Raoufi M., Maniotes J., "Why C# and why.net in the undergraduate information systems curriculum." *Journal of Information Systems Education*, vol. 43, no. 3, pp. 1-4, Mar. 2005.

[7]   Li S. F., Wang J., "Practice and exploration of experimental teaching reform for the cultivation of the students' innovation ability." *Research and Exploration in Laboratory*, vol. 29, no. 8, pp. 199-233, Aug. 2010.

[8]   Gong F. H., Xu W. W., Jiang B. B., "Reflect on quality of higher education", *Journal of Jiangsu Polytechnic University*, vol. 11, no. 2, pp 91-93, Feb. 2010.

[9]   Burns T. J., "Defining the content of the undergraduate systems analysis and design course as measured by a survey of instructors", *Information Systems Education Journal*, vol. 9, no. 5, pp. 4-17, May. 2011.

[10] Glaser, B. G. and Strauss, A. L., *The Discovery of Grounded Theory: Strategies for Qualitative Research*, Aldine Publishing Company, 1967.

[11] Van P.J.A., Pietron L. R., "Information systems development education in the real world - A project methodology and assessment", *Journal of Information Systems Education*, vol. 17, no. 3, pp. 285-293, Mar. 2006.

[12] Avison, D. and Cole, M., "Reflections on teaching information systems analysis and design: from then to now!", *Journal of Information Systems Education,* vol. 17. no. 3, pp. 253-256, Mar. 2006.