Multilevel Innovation Teaching Reform in Linear Algebra Depended on Majors' Features

--A Case Study of East China University of Political and Law

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Abstract—**Linear algebra is a core curriculum of science, economics and management majors. It is also a part of undergraduate entrance examination. It can cultivate the students' logical thinking and computational thinking for qualified examination. This paper layered students, teaching contents and examination mode into three layers, which are from down to top: knowledge level, ability level and logic level. The purpose of this method is individualized.**

Keywords- multilevel innovational teaching, linear algebra, majors' features

I. INTRODUCTION

The purpose of education is to impart knowledge and build capacity, which are different but interrelated. From twenty-first century, higher education has been popular in our country. Recent years, rapid development in science technology and economic calls for improving the mathematics quality of society labor. However, the study interest and motivation of students are different. Part of the undergraduates want to find a satisfactory job after graduation. Part of students want to continue the graduate study, or go aboard for further study or take civil servants examination.

Therefore, the students showed different mentality, different aspirations on study. Their mathematics demands are diverse. Linear algebra is a basic course in mathematics, science, and engineering departments. Generally, this course is taken in either the first or second year.

Linear algebra is an important fundamental theory course of mathematics for engineering, science, economics and management major, etc. This subject builds up the necessary mathematical foundation for students to learn basic professional lessons and follow-up professional lessons, and further expansion of mathematical knowledge. Nowadays, the teaching of linear algebra aims at their theoretical system, the logic of teaching content is strong. The students generally reflect the knowledge is abstract and difficult to understand. A large number of definitions, theories and proofs are tedious.

II. MULTILEVEL INNOVATION TEACHING REFORM IN LINEAR ALGEBRA VIA THREE ASPECTS

Actually, comparing to comprehensively master the knowledge of linear algebra, training students' basic mathematical literacy, study and innovation ability, thinking ability in study process, layered teaching pattern meeting to different demand are more important. So teaching should make students' learning process match their developing need.

(1) Layered students according to their learning ability and target.

We understand students' interest and their ability on mathematics through questionnaires and the interview form. Suggest the low level students to choose the lower study level, the students who are interested in mathematics and want to take the postgraduate entrance examination to choose the higher study level. The namelist determined is dynamic. During the teaching process, according to the students' details we will adjust the list slightly.

We try to divide the students into three layers (from down to top): knowledge level, ability level and logic level. For students in knowledge level, we focus on teaching the basic knowledge and training the ability of solving problem, facing to the successive study. For students in ability level, they will take the postgraduate entrance examination and do the science research. Their demand on linear algebra is higher. During the teaching process, the teacher need to extend the teaching contents, improve the difficulty; add some postgraduate examination as examples on class. For students in logic level, they will participate in various civil service exams. That is another selection mechanism. The students need computation ability, analysis and solving ability. For this level, we focus on training their thinking ability, especially computational thinking, logical deduction ability. Inspire students to multi-solves, multi-thinks to one problem, mathematical thinking and experience.

According to 2010 undergraduate employment intentions for specialty in computer science and technology in our university, 33% of students choose to take on further education, 20% of students choose to participate in civil service exams, 6% of students choose to study aboard, 24% of students choose to look for a job, 17% of students have unclear intention. In teaching process, the teachers try to describe the application of linear algebra knowledge in their following specialized course study according to the targets setted by students themselves.

(2) Layered teaching contents according to students' demand

According to teaching syllabus, linear algebra is the required basic courses in computer science major and economic management major, and is the mathematical tools and thinking mode for solving problems. The fundamental idea, concepts and methods of linear algebra will be used in various fields of majors.

The students in knowledge level should master the basic knowledge. Teachers design teaching syllabus according to the fundamental cultivation scheme, and focus on teaching the basic knowledge and cultivating basic ability. The teaching contents meet both the need of following courses and the need of students' employment. Therefore, the teachers teach less computational skills and proof of theorem, more typical examples and knowledge structure graph, enhanced the intuitive and application of knowledge. The emphasis are placed on the application of theorem and formulae.

The students in ability level should master the knowledge and the ability of solving practical problem. Teachers design teaching syllabus according to the postgraduate entrance examination syllabus. Focus on cultivating computational thinking and innovation ability except teaching the basic knowledge. In national postgraduate entrance examination, linear algebra accounted for 22% of the total mathematics scores.

The students in logic level students will participate in various civil service exams. Teacher deepen and widen some teaching contents. For example, the quantitative relationships part in administrative aptitude test, mainly test the candidates whether grasp the quantitative relationship between things and solve the problems of quantitative relationship. The test accesses the ability to comprehend numerical data, logical reasoning or thinking performance. In teaching process, the emphasis should place on improving the students to grasp the mathematical knowledge and logical thinking.

According to the targets of students in three levels, with respond to the knowledge module of linear algebra, set the relation as follows Table1.

Layered the excises of every knowledge module and explained them. The layers are basic level, higher level and integrated application level. The excises of basic level, mainly address knowledge level students. The excises of higher level are from the postgraduate entrance examination, leading the students of ability level and logic level to think and solve. The excises of integrated application level address to mathematical ability, such as analysis and deduce. Encourage students to look around for the solution, focus on the thinking.

(3) Layered examination according to students' various learing level

Layered examination bases on the students, thinking more ability than scores, focus on the students' individual difference. Face to the students' knowledge, ability, study attitude and various test form. It includes weekdays results and final examination results, which occupied 30% and 70% seperately. The weekdays results include homework, answering the questions in class, mainly evaluate the students' study attitude.

Once fininsh teaching one chapter, summerize the knowledge, teaching objective, arrange practise class for intepretating problems to every level. In order to investigate whether students truly understand the meaning of relevant knowledge, layer the examination contents. Help students master and consolidate the learning content and help teachers to understand the students' mastery of teaching content.

III. LINEAR ALGEBRA KNOWLEDGE WITH MAJORS' FEATURE

The direction of my school computer science major is information security. Students will learn a series of follow-up courses, such as Cryptography, Information Crime and Computer Forensics etc, which need the linear algebra knowledge. For example, with the rapid development of computer and network technology, a large number of distinctive password system emerge. Many advanced linear algebra attributes knowledge attened in, and gradually formed a modern cryptography, therefore has extensive applications, such as Hill password, ECC(Error Correction Code) etc.

IV. CONCLUSION

For front-line teacher, no matter what kind of educational philosophy and educational model, should be implemented through specific teaching and learning in the classroom to demonstrate. This paper mainly discuss how to implement "combine of teaching knowledge and cultivating ability"during linear algebra teaching process. There still are much work to do.

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Table1.Layer teaching target by knowledge modules

Knowledge Module	Teaching target		
	Knowledge Level	Ability Level	Logic Level
Determinant	Understanding definition, calculate	Expand and calculate abstract matrices	Sequence of number and variant
Matrix	Understanding definition、calculate inverse matrices	Prove inverse matrices、special matrices	Abstract computation
n-dimensional vector	Determine; Linearly dependent	Linearly present, linearly related, calculate rank of matrices	Replace
Linear equations	Solving	Various equations solving and the structure of solution	Form transformation and expression
Eigenvalue& Eigenvector	Find by definition	Solve difference and differential equations	Implicit information search
Quadratic forms	Solve standard forms	Symmetric matrices and positive definite matrices	Transformation and construction