

## Improving the construction management ability of civil engineering students

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**ABSTRACT:** In order to improve the construction management ability of civil engineering students, a correlation of the construction management ability of students has been established by comparing scores achieved by civil engineering students and their construction management ability metrics. As there are many factors that influence the scores of students, it would be difficult to evaluate the classifications of common courses, basic courses and professional courses of the teaching programmes from the perspective of principal component analysis. Hence, regression analysis has been performed on 23 selected courses related to construction management ability. A new method for improving the construction management ability of students is proposed based on cooperative education programmes. The proposed method is also helpful for experiential education of other subjects.

### INTRODUCTION

According to China's statistics, about 500 universities in China offer civil engineering courses, of which 379 offer undergraduate courses and over 140 teach postgraduate courses in this particular subject. The number of civil engineering students in China currently amounts to about 200,000 [1].

Employment statistics show that almost 70% of college and university graduates who have studied this course are later employed in construction and construction budgeting jobs. The practice of construction places specific requirements on the ability of students [2]. Employers expect these students to be proficient in surveying, map reading, construction organisation and design, adept at producing construction drawing budgets and skilled in the organisation of interior work materials.

The teaching programmes for civil engineering in most colleges and universities focus on the design of buildings and their structures, force analysis of structures and the preparation of construction drawing. Graduate projects are mostly concerned with the design of specific buildings and structures, whereas approved teaching reform projects are mostly concentrated on the innovative talent cultivation mode [3]. Courses offered in construction technology, construction organisation and construction budgeting are, however, somewhat unconnected to employment.

Despite their excellent ability in structure design and analysis, graduates, on the whole, have serious difficulty in adapting to jobs from construction companies. This is thought to be due to the widely criticised rote learning processes in education. The student is, therefore, left with a serious gap between what is taught at university on construction management and budgeting, and the actual requirements of their employer.

### CURRENT STATUS OF CIVIL ENGINEERING EDUCATION IN UNIVERSITIES AROUND THE WORLD

In the case of the world's top research-intensive universities, including Tsinghua University, Tongji University, Harbin University of Science and Technology, Cornell University, California Polytechnic State University, Southern California Institute of Architecture, their civil engineering teaching programmes are centred on engineering structure design and civil engineering research. In this context, their students usually work at design institutes or pursue further studies at home or abroad after graduation. Hence, the approved teaching reform projects and talent cultivation programmes of these universities are focused on the research abilities of students [4].

By analysing the well-regarded civil engineering courses on the Tsinghua University Web site, one can see that its national and Beijing-based courses for 2003-2010 concentrated on the areas of structural mechanics, material mechanics and soil mechanics, none of which covered the topics of construction and budgeting. The well-regarded national course

offered by the Real Estate Construction Department of Tongji University covers the full area of engineering management, including construction organisation and engineering cost management. Its syllabus is focused on construction planning and cost control, which correspond to the cultivation of construction personnel at the highest management level. However, the development of construction management ability for field personnel is mostly neglected in this respect.

For the civil engineering teaching programmes of other research-intensive universities around the world, the courses they offer do not match the requirements of jobs in practice. These universities all lack a systematic scheme for improving the construction management ability of students. Similarly, there has been a paucity of research on this issue and the research in existence is ineffective and fragmented. [5]

## REQUIREMENT ANALYSIS OF CONSTRUCTION MANAGEMENT ABILITY FOR CIVIL ENGINEERING GRADUATES

Construction management refers to the formulation of a construction's plans, the organisation and design of the construction, the procurement of materials within a set budget, and working to other time and design parameters. To carry out effective organisation and design of construction, a constructor's work involves supervising a team whilst measuring on site, completing construction logs, reporting on the construction's progress, handling quality and cost queries, whilst dealing with any other on-site issues as they emerge [6].

Construction management ability, therefore, encompasses all the necessary skills involved in devising construction and cost control plans, and the awareness of, and competency to handle any construction problems on site [7]. From the perspective of management science, construction management ability can be defined as planning, implementation and evaluation concerning construction management [8].

Based on a thorough investigation of construction companies, and by performing statistical analysis of questionnaire data, this article sums up the expectations of society towards civil engineering graduates and the requirements, which society has in general on the construction management ability of civil engineering graduates, as shown in Table 1.

Table1: General society requirements in general on the construction management ability of civil engineering graduates.

No.	Construction management ability	Requirements
1	Construction management	Project management of constructors; Organisation of construction management; Contents of construction organisation and design, and the establishment method; Dynamic control over objectives of construction projects; Construction risk management.
2	Construction cost control	Composition and calculation of installation costs for construction projects; Construction cost management and cost planning; Construction cost control and cost analysis; Settlement of installation costs for construction projects.
3	Construction progress control	Objective and tasks of progress for construction projects; Types and functions of the progress plan of constructors; Tasks and measures of progress control for constructors.
4	Construction quality control	Basics about construction quality management and quality control; Establishment and operation of the construction quality management system; Content and method for construction quality control; Processing of construction quality accidents.
5	Occupational health, safety and environment management of construction projects	Construction security management; Occupational health, safety and environment management of construction projects.

## ANALYSIS OF METHODS FOR IMPROVING CONSTRUCTION MANAGEMENT ABILITY

In this article, cooperative education institutions refer to the organisations, which cooperate with universities by providing students with working opportunities, so that students can gain first-hand working experience before their graduation; hence, improving the effectiveness of the teaching programmes. Through discussions with management personnel at different levels and technical staff of cooperative education institutions, the authors have established the specific requirements of construction companies on the construction management ability of civil engineering majors. Based on the requirements of management ability placed upon the first-level constructors in China, the authors offer a full discussion on the topic, taking expert opinion into account in the process. The relevant knowledge and awareness provided by this study, thus, makes it possible to clarify the demands on the construction management ability of civil

engineering majors, which will meet the current needs of construction companies and also promote career development of students.

Data indicating the grades of subjects studied by the construction engineering class of 2009 were collected. The metrics for evaluating construction management ability were specified. By performing data analysis of the relationship between construction management ability and the course offered during the four university years, the authors were able to find suitable methods for improving construction management ability. A corresponding scheme was, then, formulated. Owing to time restrictions, the proposed scheme was piloted based on graduation projects carried out by the construction engineering class of 2010. As opposed to the tradition of separating construction organisation and design from construction budgeting in graduation projects of engineering management and civil engineering majors, all the aforementioned areas were combined in the proposed scheme.

Some students of the class of 2011 underwent an eight-week experiential teaching programme in the summer of 2014. These students were, therefore, asked to collect project data during their experiential education programme and were required to carry out a course project on construction organisation at the end of the semester, using their already collected data. Construction budgeting based on the same projects were subsequently carried out, if time allowed.

Principal component analysis of the 34 major subjects of the class of 2009 indicates that 25 principal components are needed to account for 80% of the 34 courses. Data analysis only reveals a minor correlation between courses, as shown in the Figure 1 and Figure 2. One explanation for this could be that the grades of students are subject to many factors, making it difficult to evaluate the classification of general courses, basic courses and professional courses from the perspective of principal component analysis.

Therefore, regression analysis was carried out from the perspective of logic analysis on 23 courses deemed related to construction management ability. Construction management ability is represented by the scores of the experiential course and the construction organisation course for the class of 2009. The two courses account for 60% and 40%, respectively.

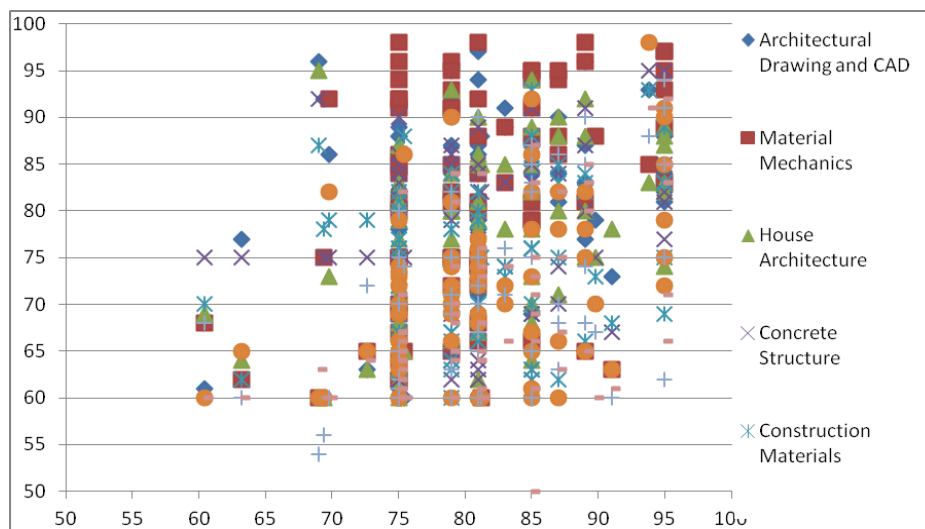


Figure 1: Scatter diagram showing the relationship between construction management and scores of relevant courses.

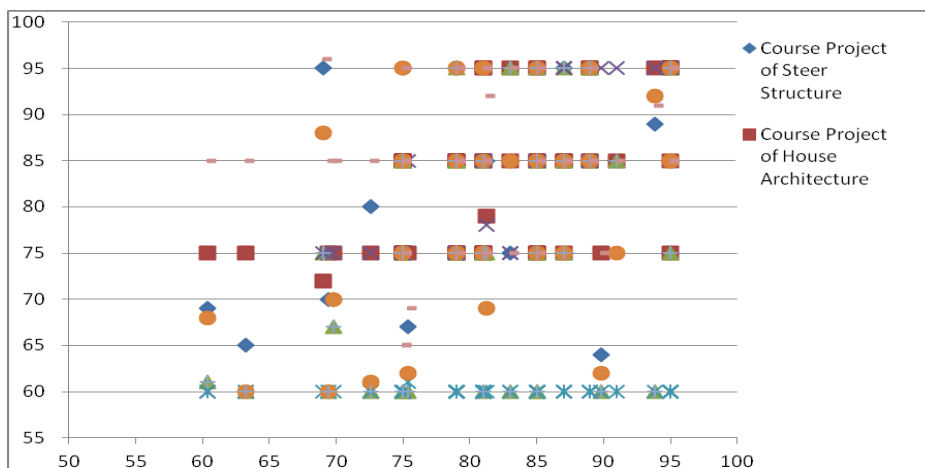


Figure 2: Scatter diagram of the relationship between construction management and experiential teaching.

Analysis results demonstrate that construction management ability is positively correlated with the following variables: architectural drawing, material mechanics, housing architecture, concrete structure, building material, construction quota, high-rise building structure, shock resistance in building, steel structure design, construction design, basic design and the practice of surveying.

Job responsibilities and ability requirements of cooperative education institutions are specified in detail and incorporated into course projects of construction organisation and construction budgeting. Meanwhile, course projects of construction organisation and construction budgeting are combined by conducting these two area within one particular construction project. In this type of combined project, a clear relationship is established between construction site layout, construction plan, progress plan, resource plan, quota project division, engineering measurement and engineering valuation. The key points and contents of evaluation are, thus, defined.

Effectiveness of teaching can be improved in future teaching programmes by studying the following issues. First, theoretical and experiential teaching of courses on construction technology, construction organisation, and quota and budget estimation need to be better scheduled based on the timetable of cooperative education to improve teaching effectiveness. Secondly, course content should be tailored to meet the needs of future employment responsibilities.

## CONCLUSIONS

For theoretical teaching of professional courses and course projects, both course content and a time schedule should be tailored to job responsibilities of cooperative education. The construction management ability of students can be improved by devising construction plans and setting construction budgets.

Methods for correctly evaluating construction management ability should be developed. On the one hand, these methods could analyse the effectiveness of courses and cooperative education offered. On the other hand, they can provide relevant feedback on construction management ability evaluation and, thus, provide advice on further optimisation of the teaching programmes.

Because construction management ability plays only one part in the ability, which civil engineering graduates should possess, the teaching programmes, curriculum and grade evaluation should not be focused solely on this one attribute. Taking into account comprehensive requirements on the ability of civil engineering students, the following proposals are made.

- Universities should cultivate graduates who have the potential to be future civil engineering experts, and more importantly, cultivate who can meet current requirements of the construction market. To keep abreast with the market, surveys should regularly be conducted to provide representative samples from construction companies, combined with face-to-face interviews and on-line questionnaires, in order to provide critical information on current trends in the field.
- Improve the teaching programme and curriculum of the civil engineering subject, and arrange a reasonable time schedule for cooperative education.
- Introduce flexibility into the contents of the construction and budgeting course projects. The construction organisation and construction quota course projects could be incorporated, for example, with the budget estimation course project.

The task document of the civil engineering graduation project (construction and budget) that has been drawn up was piloted involving the class of 2009. In the proposed graduation project, instructors and teachers collected design files and drawings of actual construction projects and, subsequently determined the theme of their graduation project based on the requirements specified in the task document.

As the drawings and construction requirements were obtained from actual construction projects, construction organisation poses severe challenges to students, who are expected to comprehend the building and structure design, read the drawing, use the drawing set, properly devise construction schemes, and to lay out suitable field construction plans.

This graduation project also places great emphasis on the budgeting ability of students, to calculate and apply quotas accurately, and to perform unit price analysis precisely. Evaluation of graduation projects performed by students choosing the construction budgeting subject highlights that the proposed teaching programme is very effective.

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