World Transactions on Engineering and Technology Education
Vol.12, No.3, 2014

Exploration of modular teaching of the *Deformation Monitoring and Data Processing* course in the Surveying and Mapping engineering major

Ning Gao & Cai-Yun Gao

Henan University of Urban Construction
Henan, People's Republic of China

ABSTRACT: The course, Deformation Monitoring and Data Processing, is one of the most important and basic core courses of the Surveying and Mapping engineering major in higher education. Discussed in this article are the content and teaching methods of the revised, modular Deformation Monitoring and Data Processing course. This new modular course includes five key components, viz. basic knowledge in deformation monitoring, data pre-processing, adjustment of the deformation monitoring network, deformation forecasting and engineering practice. The new course is more practice-oriented, it raises the interest of students and improves teaching outcomes.

INTRODUCTION

With the great improvement of human society and the rapid development of the world economy, all kinds of engineering projects, such as high-rise buildings, tunnels, viaducts, river bridges and riverbanks, as well as mining of mineral resources, have been undertaken. Subsequently, the over-exploitation of fragile natural resources and the unreasonable development and utilisation of space, can cause a variety of geological disasters [1].

These could include surface subsidence resulting from the excessive exploitation of solid, liquid or gas underground resources, building settlement deformation due to the change of ground loadings, as well as local earthquakes and landslides induced by the effects of dams.

Such disasters have caused great damage to the life and property of people all over the world and, in practice, these kinds of disasters are closely associated with deformation. Therefore, monitoring deformation of natural and manmade structures to analyse, interpret and make accurate predictions has been one of the most important research subjects in the surveying and mapping sciences and related disciplines.

For this reason, a course in deformation monitoring and data processing is a compulsory part of the surveying and mapping engineering major at many universities.

Deformation Monitoring and Data Processing has two components: deformation monitoring technology and deformation data processing. After the course, students should have mastered how to monitor deformations (e.g. high-rise buildings, tunnels, dams, bridges), how to design a deformation monitoring plan, how to deal with deformation monitoring networks and how to analyse and forecast deformation.

The course is interdisciplinary involving surveying and mapping, hydrology, geology and many other subjects. There are many problems in traditional teaching, such as a narrow course focus, few options and failing to adapt to the diversified development of students. What is more, the inflexibility of the course makes it hard to change the curriculum.

The traditional model of teaching, with its lack of creativity, is task- and experiment-oriented. The evaluation leads to poor differentiation by achievement among students and a lack of enthusiasm [2][3].

Described in this article is a modular teaching programme applied to the 2014 undergraduate student class majoring in surveying and mapping engineering at Henan University of Urban Construction. The programme integrates development trends of deformation monitoring and is based on recent teaching practice. The programme has achieved good results.

THE STATUS QUO AND PROBLEMS

A course in deformation monitoring and data processing is one of the most important basic courses of the surveying and mapping engineering major in higher education. As early as a decade ago, the course was offered to students majoring in surveying and mapping engineering at Henan University of Urban Construction. However, the teaching of deformation monitoring and data processing failed to keep pace with the times.

A number of problems had developed. There was a decrease in the number of students who choose the course. This was largely due to the unvaried and boring teaching material and methods. The application of new technologies and new approaches to deformation was not adequately covered.

Practical and experimental teaching is a key factor in higher education and plays an important role in the reform of courses [2][3]. Nonetheless, due to the lack of high precision instruments and equipment, the traditional teaching pattern uses the *cut-and-try* method, i.e. students are randomly divided into several groups to carry out experiments based on conventional teaching.

Deformation monitoring is a systematic engineering discipline at the intersection of many branches of learning. As a result, teachers give priority to theory and pay little attention to practice. Teaching content and teaching methods are out-of-date, which restrict the cultivation of innovative talent.

ESTABLISHMENT OF A MODULAR TEACHING PATTERN

Modular Teaching

Modules in Modular Teaching form the constituent parts of the teaching, and are arranged and combined to achieve the best teaching effect [4][5].

Modular Teaching Content

By combining the characteristics and development trends of deformation monitoring, a modular teaching pattern is proposed based on recent teaching practice. The modular teaching pattern divides the Deformation Monitoring and Data Processing course into five major modules, viz. basic knowledge in deformation monitoring, data preprocessing, adjustment of deformation monitoring networks, deformation forecasting and engineering practice.

Each module is completed within a fixed time and the five modules are taken in parallel. Each of the modules is now described in more detail.

Basic knowledge in deformation monitoring: deformation monitoring technology, a scheme to monitor deformation and new technology modules, are the three critical teaching components of this module. In this module, teachers focus on the concepts and connotations of deformation monitoring, with examples of engineering construction, resources exploitation and transportation projects. This enables students to understand the important role of deformation monitoring in social and economical development, and helps students acquire a better understanding of new techniques (such as remote sensing, the global positioning system, photogrammetry), to monitor deformation disasters. Through this module, students come to understand the purpose, significance and methods of deformation monitoring.

Data preprocessing: after obtaining monitoring data through all kinds of monitoring instruments and equipment, it is necessary to undertake data pre-processing before data analysis. The teaching of this module mainly contains two sub-modules: data checking and gross error detection. Data checking involves the analysis of the accuracy and reliability of data monitoring, as well as the performance, and statistical and logical correctness of the original records. Gross error detection checks for gross random errors, which do not obey normal distribution. Gross errors greatly affect follow-up data processing. Therefore, statistical methods must be used to detect gross errors.

Adjustment of deformation monitoring networks: the data checking eliminates gross errors from the observational data of the deformation monitoring network. It is necessary to adjust the calculation of a monitoring network. This module contains two sub-modules, viz. classical adjustment of free networks and adjustment of rank defect-free networks. Students must master this module, since it is the core module of deformation monitoring data processing.

Deformation forecasting: deformation forecasting, which is the main factor in decision-making based on deformation data, plays an important role in protecting the safety of people's lives and property. The quality of deformation forecasting directly influences the quality of the whole monitoring. Therefore, increasing the accuracy of forecasts of deformation is an important issue. Numerous researchers have studied the deformation forecasting for quite a long time and have developed various models, including the linear regression model, time series model and artificial neural networks. Since these methods are efficient, convenient and accurate, they have been used in a wide range of applications. Considering the cognitive level of undergraduate students, teachers mainly focus on regression analysis, grey system theory and time series.

It is difficult for teachers to teach this module in a classroom and difficult for students to learn after class. In order to overcome these obstacles, a software program for deformation forecasting has been developed to solve practical problems. As shown in Figure 1, it is software for deformation forecasting developed by students.

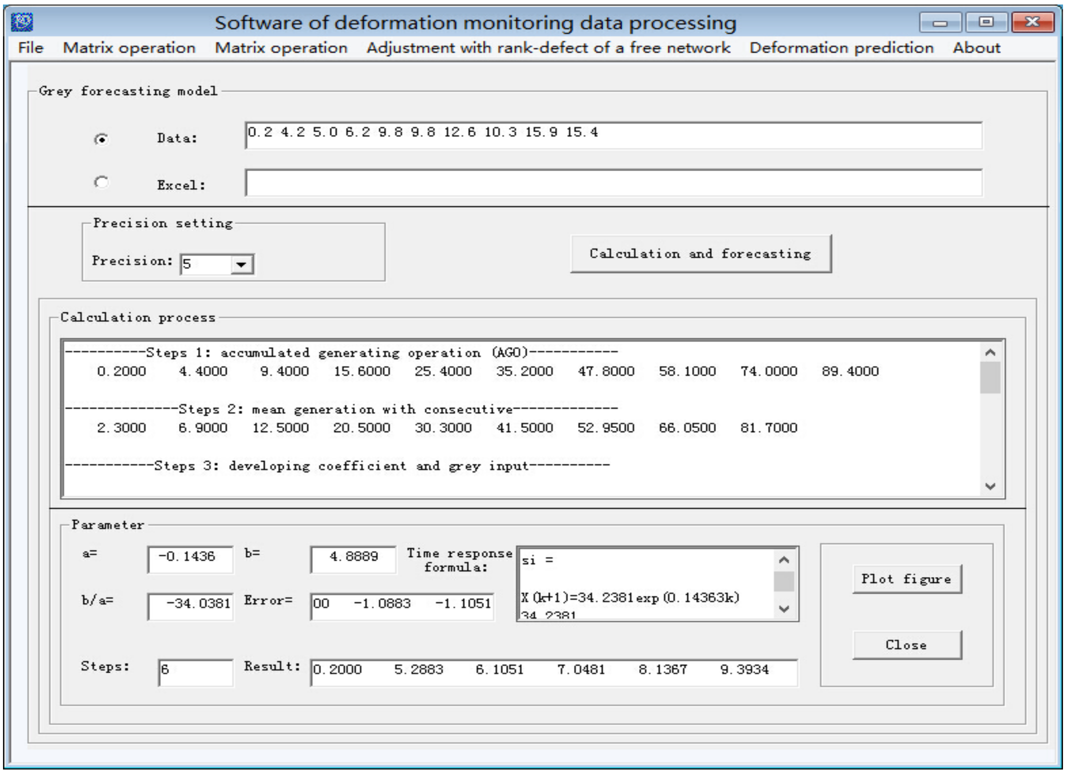

Figure 1: Deformation forecasting software developed by students.

Engineering practice: students master the basic theory of deformation monitoring and data processing by studying the previous four modules. But this module is designed to improve students’ practical ability. In this module, students on weekends undertake practical work in the area near the school. An example of the result is shown in Figure 2, which deals with monitoring land disasters caused by underground mining.

Figure 2: Land disasters caused by underground mining.

Connotative Meaning of Modular Teaching

The basic principle of dividing the teaching unit into components is to make sure the teaching content is relatively cohesive. Generally speaking, a chapter of a textbook should contain a complete teaching topic, so the content of a whole class (45 minutes) or several classes should be regarded as a teaching unit. In the curriculum of the course Deformation Monitoring and Data Processing, two classes (90 minutes) are considered to be a complete teaching unit.

Teaching content, which is a linear presentation of text and other materials, is carried out in the 90 minutes of classroom teaching. During classroom teaching, teachers should have a thorough grasp of the textbook used, and the teaching should move from easy to difficult and from light to deep, according to the cognitive level of students and the teaching goals.

Teaching practice should focus on teaching goals. The content of teaching material should be comprehensive and integrated with a sub-model approach to avoid duplication, and to realise mutually complementary and cohesive teaching modules.

Modular Teaching: Multimedia and Traditional

There are two forms of teaching: multimedia teaching and traditional classroom teaching. These are co-ordinated. The teaching method is where teachers act as leaders. Full use is made of multimedia courseware and the combination of multimedia courseware, blackboard writing and lectures.

EXPERIENCE AND RESULTS OF IMPLEMENTING THE MODULAR TEACHING SYSTEM

After two years' application of modular teaching to the course, Deformation Monitoring and Data Processing, the authors find that the modular teaching pattern has the following advantages:

- Modular teaching allows the use of a variety of teaching methods, such as a *project driven* approach, *research* and *experience,* and it improves the teaching quality.
- Modular teaching makes it possible for students to choose differing modules freely, according to their own discipline and interest. This enables a student's potential to be more fully tapped.
- Each module is relatively independent so that it is relatively easy to add information about the latest technology to each module, so as to constantly enrich each module.
- Modular teaching maintains the integrity of both theory and practical teaching.

The modular teaching pattern requires that teaching should give priority to material that is practical and less to teaching material that is too theoretical. The former teaching material should be explained thoroughly, while the latter should be explained straightforwardly. This approach to teaching makes good use of both theory and practical teaching, as well as improving teaching quality.

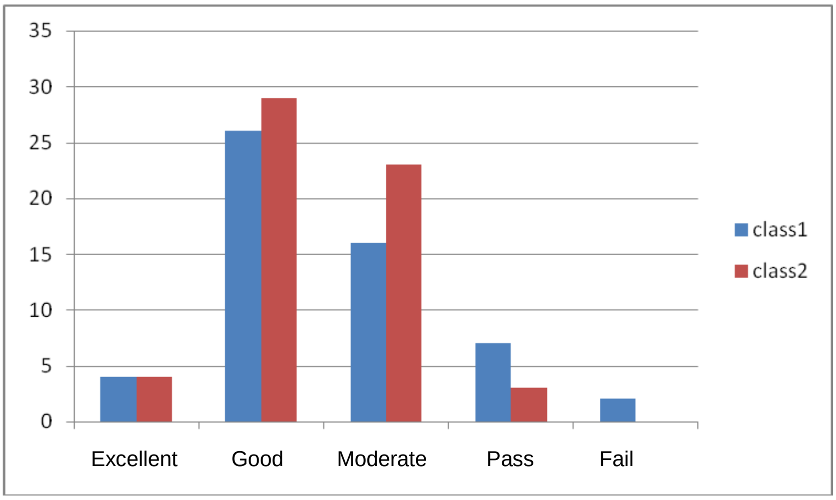

Figure 3: Teaching effects of Deformation Monitoring and Data Processing in 2014.

Research subjects in a survey were 114 students majoring in surveying and mapping engineering at Henan University of Urban Construction. The results of the survey of class 1 and class 2 students are shown in Figure 3.

According to the statistics, 7.01% of the students were excellent in this course, and 48.2% were good; 34.2% were moderate; 8.77% passed, while 4.4% failed. The statistical results show that the student results are distributed in a nearly normal distribution and the teaching yields good results.

It has been found that the modular teaching method promotes students' enthusiasm for learning and provides them with multiple forms of learning.

CONCLUSIONS

With the development of deformation monitoring technology, deformation monitoring has extended to safety and prediction, which involves multiple disciplines. Deformation Monitoring and Data Processing is a compulsory course for undergraduate students of the Surveying and Mapping engineering major. The teaching content should also be adjusted to keep pace with the development of modern monitoring technology.

Modular teaching, which incorporates new practice in deformation monitoring and data processing, promotes students' innovative and practical abilities. The modular teaching approach overcomes the shortcomings of traditional teaching of deformation monitoring and data processing, giving full play to students' initiative and creativity, while improving the quality of teaching.

ACKNOWLEDGEMENT

This work was supported by the Teaching Reform Foundation of Young Teachers' Teaching Research Project in Henan University of Urban Construction, of Research on Cultivating Innovative Talents Based on Organisation and Implementation of Geomatics Skill Competition for College Students (201431).

REFERENCES

1. Zhang, Z.L., *Engineering Geodesy*. Wuhan: Publishing House of Wuhan University, 175-212 (2002).
2. Zhu, B.X., Discovery on curriculum reform of deformation monitoring and data processing. *Beijing Surveying and Mapping*, **2**, 96-98 (2010).
3. Yang, H.C., Deng, K.Z., Zhang, S.B., Zhen, N.S. and Cai, C.S., Discussion on modern surveying and mapping and the cultivating mode of innovative person with ability in the major of surveying and mapping engineering. *Engng. of Surveying and Mapping*, 15, **2**, 73-76 (2006).
4. Tao,H., Zhuang,Y.M. and Yu, R.Z., Modular teaching system design based on developing innovation spirit and practice ability. *J. of Shandong Institute of Commerce and Technol.*, 8, **5,** 39-42 (2008).
5. Yuan, M., Xu,Q., Wang, X.F., Tan, M. and Zhang, X.D., Research on modular teaching reform based on applied talent cultivation: referencing the successful experience of German FH. *J. of Hefei University (Natural Sciences)*, 21, **4**, 56-60 (2011).