World Transactions on Engineering and Technology Education
Vol.13, No.1, 2015

New teaching methods and their effects on the *Data Acquisition and Interface Technology* course

Liang Ge†‡, Ze Hu†, Mingjiang Shi†, He Zhang†, Junbi Liao‡ & Yuanhao Wang†

Southwest Petroleum University, Chengdu, People's Republic of China†
Sichuan University, Chengdu, People's Republic of China‡

ABSTRACT: *Data Acquisition and Interface Technology* is a professional foundation course for students majoring in measurement control technology and instrumentation at Southwest Petroleum University in Chengdu, China. As a national distinctive major, it is an important course to deliver and, therefore, this study taking one of the classes in 2011 as an example, focussed on and examined the teaching process from the perspective of theory and practical skills. Specifically, the objective of the study was to research the effect of blackboard writing and multiple teaching method on the students' studying enthusiasm and initiative, along with their practical ability and creativity. The results obtained suggest that the proposed teaching method is useful and effective, and that the method has helped reach the major's professional cultivation requirements as set up by the syllabus outlined in the engineering education system.

INTRODUCTION

Data Acquisition and Interface Technology, as one of the compulsory courses for measurement and control technology and instrumentation, is a course greatly related to practical use, and can be applied to many science and engineering fields. The course, which focuses on basic theory and concepts, effectively combines software and hardware, design methods and practical applications. Through learning this course, students can master the basic skills of data acquisition and interface technology, understand the design method of hardware and software of data acquisition systems, lay the foundation for future jobs, which may involve computer data acquisition or microcontroller based data acquisition and processing.

According to the syllabus of the course, the authors arranged 10 weeks for teaching tasks, including 32 hours of classroom instruction and eight hours working in the laboratory, a total of 40 hours of study. Through 10 hours of the course-learning, students are required to master the basic techniques of data acquisition and interface, and to understand the hardware design methods and data acquisition system software.

To expand students' knowledge, as well as letting them understand the detailed application of data acquisition and interface technology in various fields (such as environmental monitoring and downhole tools), the course syllabus also specifies the reference materials for students during the teaching process (see References [1-7]). In addition to the reference books, students can also refer to the relevant network resources and related sites; as suggested by Zieliński, as well as Mahnič and Gams [8][9].

TEACHING METHODS

The Combination of Theoretical Teaching and Practical Teaching

The curriculum includes theory teaching and practical teaching. Theory teaching, a total of 32 hours, is dedicated to the teaching contents, and the topics allocation versus the number of hours is as follows:

Chapter 1: Introduction (2 hours);
Chapter 2: Digitising of the simulative signal (3 hours);
Chapter 3: Simulative multiplexer switches (5 hours);
Chapter 4: Measuring amplifier (4 hours);
Chapter 5: Sample/retainer (2 hours);
Chapter 6: The A/D converter (4 hours);
Chapter 7: The D/A converter (6 hours);

Chapter 8: Data acquisition interface board (4 hours);
Chapter 9: Data acquisition system design (2 hours).

The authors have arranged four hours per week for the theory teaching in the sequence of eight weeks. The experimental teaching includes a total of eight hours during which the detailed experiment contents are as follows:

- PC bus industrial control D/A conversion experiment (2 hours);
- PC bus industrial control D/A conversion experiment (2 hours);
- D/A conversion experiment under WINXP (2 hours);
- Programming light loop experiment under WINXP (2 hours).

Students are required to master the basic usage of the data acquisition card and the methods of the commonly used A/D, D/A converter chip with microcomputer interface. In the course of the teaching, the authors aim to cultivate students' self-study ability, practical ability, innovative ability, as well as stimulating students' interest in the subject.

The Combination of Blackboard Writing and Diversified Teaching Forms

Blackboard writing and multimedia tools are used at the same time during the process of teaching. The authors use the blackboard writing to explain abstract concepts and principles, also for the elaboration of the calculation formula of the sampling theorem. The main purpose is to inspire students' thinking ability and to let them know the details of this part in the process of derivation and interpretation.

What is more, multimedia presentations are used for some electronic components and circuit diagrams with more complex internal structures, such as a three-phase AC motor in the form of animation. By so doing, students' perceptual knowledge of a motor will be enhanced and the basic structures of the motor will be formed in their mind. Still, the computer simulation can be put into use, so as to develop students' ability of self-discovery. By learning how to use electronic circuit software, such as Protel, Multisim, Proteus, students can better understand the classroom teaching content, as well as further develop their comprehensive analytical skills and innovative ability. Such steps are for the purpose of promoting their self-development [10][11].

TEACHING EFFECT ANALYSIS

Research Subjects

Taking the measurement and control technology and instrumentation class of the group of 2011 students that consists of 32 students in the class, as research subjects, the course (the data acquisition and interface technology) started in the spring of 2014 (junior).

Assessment Methods

The course grades are made up of two parts (the class grades and the grades of the final test). The class grades account for 30% of the total grade, mainly including the experiment results, attendance, homework completion, students' response to the class content. The final test grades account for 70%. The final test generally consists of blank-filling (18 points), multiple choice (20 points), and 6 calculation comprehensive problems (62 points). The overall rating scores = class grades x 30% + final test grades x 70%.

Teaching Effect Analysis

Figure 1 is the class grades range chart of the students; some students are rewarded because they sometimes answer the questions actively and finish their homework seriously, which demonstrates their learning enthusiasm.

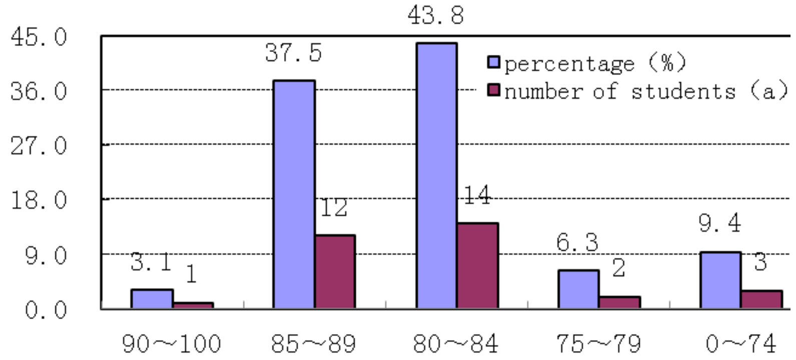

Figure 1: Class grades range of the students (points).

Figure 1 shows that only one student had class grades in the range 90-100, which represented 3.1% of the whole group of students. Twelve students had results in the range of 85-89, giving 37.5%, and 14 students (43.8%) scored in the range 80-84. This resulted in 27 students receiving more than 80 points, which accounted for 84.3%. This result confirms their on-going good performance and their keen interest towards this course [12][13]. This occurrence also matched with their active performance during the class and good completion of the homework. At the same time, there were three students with the results between 0-74 points, accounting for 9.4%, this fact is actually reasonable by considering their lack of passion demonstrated during classes and occasional absence from the class.

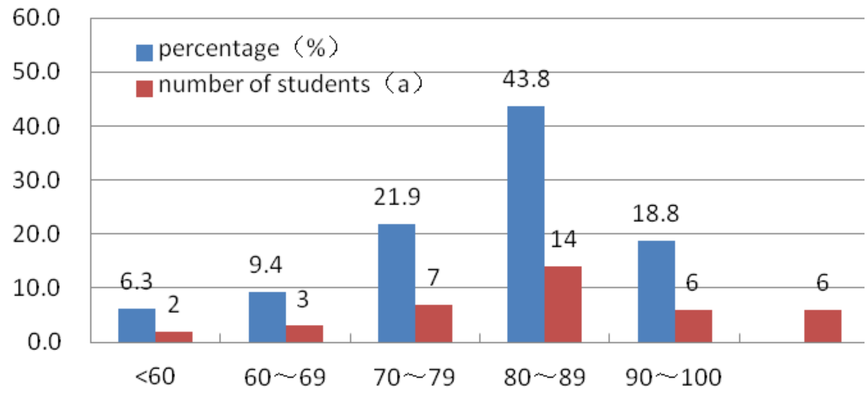

Figure 2: Final test grades range of the students (points).

Figure 2 shows the final test grades range chart of the students, and the points range is between 0 and 100. It can be seen in this figure that there were six students whose final test grades were in the range of 90-100, that is 18.8% of the entire group. Fourteen students had results between 80-89 points, which is 43.8% of the whole group. There were seven students with the results between 70 and 79 points (21.9%). So, a total of 27 students whose class grades were more than 70 points, accounted for 84.5%. Most of the students' test scores were fairly good, which suggests that the *two-combination* teaching method was effective. However, at the same time, the authors also found that some problems required action for further improvement. These included the fact that two students received test scores less than 60 points, which represented unsatisfactory performance in the course.

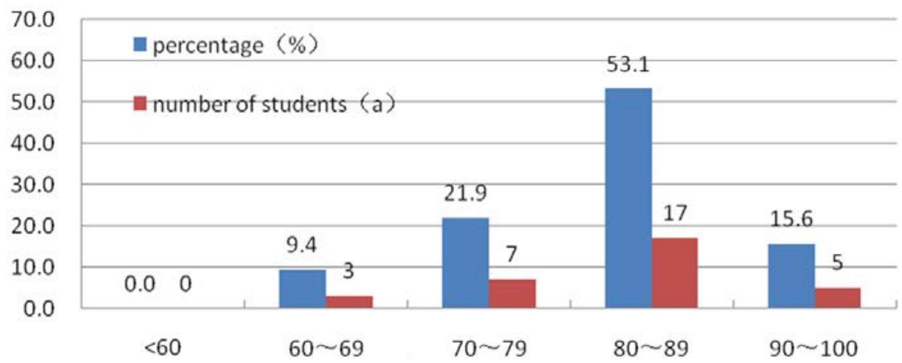

Figure 3: Overall rating scores range.

Figure 3 is the overall rating score graph, which is made up of 30% of the class grade and 70% of the final test score. According to the chart, it can be seen that there were five students whose overall scores were over 90, accounting for 15.6% of the whole group, and 17 students received results in the range 80-89 (53.1%). It can be seen that 22 students gained results above 80 points, accounting for 68.8%. Furthermore, the entire group of 32 students obtained results greater than 60 points (the pass mark), accounting for 100%. Hence, it may be concluded that the combination of the two methods has a good teaching effect.

CONCLUSIONS AND SUGGESTIONS

The authors found that optimising the evaluation system by varying the proportion of the final examination versus other assessment activities may strongly influence the total score. The assessment form is the measure of teaching quality; for instance, students will only focus on theoretical knowledge when the assessment is in the form of final examination, which is not conducive to full and comprehensive development of the knowledge, skills and attitudes acquired by students. Hence, seeking a flexible evaluation system is absolutely necessary for not only stimulating students' independent learning, but also improving their thinking abilities. Thus, putting different weightings on different teaching/learning activities is of tremendous importance. For example, the examination scores can be set at, say, 60% of the total score, whereas the remaining 40% of the final score can be allocated to self-study, homework, laboratory performance, written reports and presentations, classroom performance, as well as other quiz-type assessment methods.

When optimising the examination, teachers may increase the number of practical questions so that the theory-based examination assessment requires students to use theoretical knowledge to solve practical problems or explain certain phenomena, which appear in the actual practical application. The types of questions should also be diversified; teachers should also set some judgmental-type questions, as well as questions requiring theoretical analysis in order to test students on how well they have mastered the course from a different perspective.

The clue of modern assessment is combining theoretical knowledge with practical application. Getting some senior students, who work on graduate designs that relate to data acquisition and interface technology is very useful as they may suggest some assessment questions relating to the application of theoretical knowledge in their practical designs. By doing so, teachers can widen the spread of the concepts and ideas of data acquisition and interface technology in practical application.

In order to enhance students' initiative further, students are required to demonstrate their subjective initiative in the learning process, especially, where strong practical skills are demanded; for example, when performing data acquisition and applying interface technology. During the teaching process, teachers can create a specific environment where students can explore advanced knowledge according to the teaching syllabus. For example, when teaching about data acquisition electronic circuits, teachers can discuss the AD converter internal principles coupled with some questions. Moreover, students can use the simulation software to design the data acquisition circuit, which cultivates students' abilities to search for information, and develops their positive thinking and practical knowledge. Accordingly, they can complete the construction of knowledge through self-study and self-development.

ACKNOWLEDGEMENT

This work is supported by the Scientific Research Starting Project of SWPU (No.2014QHZ029), the National Natural Science Foundation of China (No.21204139) and the State Administration of National Security (No.sichuan-009-2013AQ).

REFERENCES

1. Lombardi, R., Coldani, G., Danese, G., Gandolfi, R. and Leporati, F., Data acquisition system for measurements in free moving subjects and its applications. *IEEE Trans. on Instrumentation and Measurement*, 52, **3**, 878-884 (2003).
2. Luo, F. and Ye, H., DSP-based tension control and data acquisition for paper machine rewind roll drive. Industry Applications. *IEEE Trans. on Industry Applications*, 36, **4,** 1018-1025 (2000).
3. Rubaai, A., Ofoli, A.R. and Cobbinah, D., DSP-based real-time implementation of a hybrid H adaptive fuzzy tracking controller for servo-motor drives. *IEEE Trans. on Industry Applications*, 43, **2**, 476-484 (2007).
4. Sabatini, A.M., Genovese, V. and Maini, E.S., Portable system for data acquisition and transmission based on handheld PC technology. *Electronics Letters*, 38, **25**, 1635-1637 (2002).
5. Rongen, H., Hadamschek,V. and Schiek, M., Real time data acquisition and online signal processing for magnetoencephalography. *IEEE Trans. on Nuclear Science,* 53, **3**, 704-708 (2006).
6. Rubaai, A., Castro-Sitiriche, M.J. and Ofoli, A.R., DSP-based laboratory implementation of hybrid fuzzy-PID controller using genetic optimization for high-performance motor drives. *IEEE Trans. on Industry Applications*, 44, **6**, 1977-1986 (2008).
7. Ling, Q., Liu, S. and Li, Z., The data acquisition system design of portable coordinate measuring machine. *Proc. Inter. Symp. on Photoelectronic Detection and Imaging*, 7381 (2009).
8. Zieliński, W., The application of the Bologna Declaration in Polish technical universities. *World Trans. on Engng. and Technol. Educ*., 1, **1**, 137-140 (2002).
9. Mahnič, V. and Gams, M., Some experiences in teaching introductory programming at the faculty level. *World Trans. on Engng. and Technol. Educ*., 2, **3**, 441-444 (2003).
10. Fink, F.K., Problem-Based Learning in engineering education: a catalyst for regional industrial development. *World Trans. on Engng. and Technol. Educ*., 1, **1**, 29-32 (2002).
11. Njock Libii, J. and Drahozal, D., Influence of the magnitude of the angle of attack on the voltage produced by a miniature wind turbine. *World Trans. on Engng. and Technol. Educ*., 9, **3**, 155-160 (2011).
12. Ragheb, M. and Ragheb, A.M., *Wind Turbines Theory - The Betz Equation and Optimal Rotor Tip Speed Ratio*. In: Rupp Carriveau, R. (Ed), Fundamental and Advanced Topics in Wind Power. Rijeka: InTech, 19-38 (2011), 15 August 2011, www.intechopen.com/articles/show/title/aerodynamics-of-wind-turbines
13. Abarzadeh, M., Kojabadi, H.M. and Chang, L., *Small Scale Wind Energy Conversion Systems*. In: Al-Bahadly, I. (Ed), Wind Turbines. Rijeka: InTech, 639-652 (2011), 15 August 2011, www.intechopen.com/articles/show/ title/small-scale-wind-energy-conversion-systems