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STUDY ON THE EXPERIMENTAL EDUCATION MODEL FOR ROBOT INTEGRATED DESIGN COURSE BASED ON 6S MANAGEMENT AND COMPETITION MECHANISM

Um estudo sobre um Modelo de Educação Experimental para o Curso de Design Integrado de Robôs Baseado num Mecanismo de Competição e de Gestão 6S

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Abstract: : Experimental education is an important part of higher education. How to upgrade the level of education and management so as to better serve practical teaching is an arduous task. This paper presents a new education model based on 6S managementand competition mechanism. In particular, aiming at the course of robot-integrated design, which is a typical experimental course in Wuhan University, the author does useful exploration and practice on implementing and validating the teaching model. The result supports the usefulness of this approach, and it demonstrates that this teaching model improves not only laboratory management quality but also teaching quality, furthermore, it promotes cultivating creative spirit, practical abilityand cooperation consciousness of universities students.

Keywords: 6S management; Competition mechanism; Experimental education model; Robot integrated design

Resumo: A educação experimental é uma parte importante do ensino superior. Como elevar o elevar o nível de educação e gestão de modo a servir melhor o ensino prático é uma tarefa árdua. Este trabalho apresenta um novo modelo de educação baseado na gestão 6S e mecanismo de competição. Em particular, visando o curso de design integrado ao robô, que é um curso experimental típico na Universidade de Wuhan no qual se fez uma exploração útil e prática na implementação e validação do modelo de ensino. Os resultados apoiam a utilidade dessa abordagem e demonstram que esse modelo de ensino melhora não apenas a qualidade do gerenciamento do laboratório, mas também a qualidade do ensino, além de promover o espírito criativo, a capacidade prática e a consciência de cooperação dos estudantes universitários.

Palavras-chave: gestão 6S; Mecanismo de competição; Modelo de educação experimental; Design robô integrado.

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INTRODUCTION

The experimental education plays an important role in cultivating creative spirits and practical abilities of university students. Many teachers attempt to reform the education mode to improve the teaching quality. They have been studying on applying advanced management model in laboratory management and innovative evaluation system in experimental courses (Rock Braithwaite, Philip J. Corr, 2016).

As a successful management model, 6Soriginated from Japanese enterprise management and developed from field management, including SEIRI, SEITON, SEISO, SEI1KETSU, SECURITY and SHITSUKE. The Roman transcriptions of these six Japanese words begin with "S", so they are known simply as "6S". It has been wildly used in enterprises because of its simplicity, practicality and remarkable effect (Hao Jielai, Yi Kechuan, 2015). Its basic idea can be summarized as follows. The production factors such as personnel, machine, materials and methods should be effectively managed in manufacturing site, and we could have a neat, clean, and comfortable working place and scientific and rational distribution-working environment. With the effective implementation of management system, the quality of human being has been improved, and excellent groups will spring up (Long Weizhong, 2012).

In recent years, the idea of 6S management has been introduced in university laboratory management; many managers and teachers have done a lot of related work and made great progress. The purpose of such exploration is trying to create a perfect experimental environmentsuch as in an enterprise workshop, and completely improve the level of laboratory management in universities. 6S management was applied in the laboratory center. As a result, the management quality had been increased and the management cost had been reduced. Besides, security risks had been timely eliminated (Zhang Dongmei et al., 2010). The application of 6S model was introduced in the equipmentquality inspection laboratory. This practice showed that the approach played an import role in the standardization of laboratory management and the cultivation of the competence of students (Dong Zhenqi et al., 2012).

Scientific and technical competition isa significant carrieroftraining university students' comprehensive quality, and it plays a promoting role in teaching and learning. It has been paid more and more attention by teachers and students (Xiao Jing et al., 2013). At present, a number of competitions are hold every year, for example, mathematical contest in modeling, electronic designing competition, robot competition, mechanicalcreative design competition and physics contest. Some researchers and university managers consider how to better take advantage of these discipline competitions to serve the practical education (Dong Cuimin, Liu Yongqiang, 2011). Some researchers studied on the exploration and practice of innovation ability training of university students, by means of using small robot platform(Chen Bo et al., 2009). By analyzing the significance of participating in robot contest and taking into consideration the actual conditions in his school, Chen Wei explored the cultivation mode of the innovative capability of university students in the new era(Chen Wei, 2012).

BACKGROUND TO INNOVATE THE COURSE OF ROBOT INTEGRATED DESIGN

Teaching objective of robot integrated design course

The course of robot-integrated design is a practical course for the students majoring in measurement & control technology and instrumentation in Wuhan University. It emphasizes on cultivating creative spirit, practical ability and cooperation consciousness of the students. It is a integrated platform of knowledge application, and focuses on robot design and manufacture. The course can help the students to learn more knowledge about thetypical machinery structure theory, testing technology, single chip technology and communication technology. It can also help them understand some basic characteristics and applications of multiple sensors. The students will be taught to realize motion control using automatic control principle and mechanical & electrical transmission control theory, and they could develop their capacities of analyzing problem and solving problem, which are related to robot positioning and attitude determination, motion planning and environment perception. The students would obviously derive benefits from this course and they could have more interests and potentials in further research on robotics.

Characteristics of robot integrated design course

The course has 36 class hours during four and a half weeks, and it is creatively arranged eight stage tasks and a contest as anexamination. In order to complete the tasks, the students have to work overtime, and usually spend several times extracurricular time more than the time of class. The stage tasks and contest includethe content below.

1) Assembling a robot car and understanding experimental hardware platform.
2) The robot car moving in straight line and turning with a right angle.
3) Performing self-tracking moving based on QTI (Quick Track Infrared).
4) Implementation of RFID(Radio Frequency Identification) card reader and voice broadcast.
5) Implementation of PS2 joystick and ultrasonic obstacle avoidance.
6) Carrying out color-based object picking placing.
7) Performing vision-based and remote control fire extinguishment.
8) Implementation of flame sensor and participating in the fire extinguishment competition.

Components of Robot Car Assembled Robot Car

Figure 1 Robot Car Used in the Course

The experimental hardware platform is a robot car based on STM32F4 microcontroller (as shown in Figure 1) that is independently researched and developed by us. Hundreds of components should be precisely assembled by students in the course, and each module of the robot car needs to work properly. Besides complicated circuit systems such as the circuit system of QTI, RFID, WIFI, current monitoring, power management, manipulator control, servocontrol, DC motor Driver, color identification and cartwheel's resurvey, the main parts of a robot car are as follows: a base board and a roof board, fixed brackets, DC motors, wheels, shock attenuation devices, two-degrees of freedom mechanical arms, actuators, machine handles and receivers, a camera, a fan, a ST-LINK V2 debugger, speakers, Li-ion batteriesand a charger, a 128MB Micro TF card, and more than 20 different sensors.

Problems of robot integrated design course

In previous experiments, although a lot of work has been done to improve our management levels and teaching methods, the result seems unsatisfactory. The problems can be outlined as follows.

1) The bad experimental conditions cannot only attract students, but they usually lack initiative studyand confidence in fulfilling the tasks.
2) The students did not abide by the class disciplines and experimental regulations. The operational errors were very common in the class, and the damage rate of experimental equipment and the robots was high.
3) The teachers could not smoothly finish the teaching tasks, and they had to pay more attention to class disciplines and usually complain the managers and students.
4) The teaching effects are hard to be promoted. The students were short of responsibility consciousness and cooperation consciousness, not to mention innovation spirits.

Necessity of reformation and innovation of robot integrated design course

As mentioned above, it is obvious that the course is tough and it is a challenging for both the students and the teachers. How to carry out and manage the course is worthy of exploring. Factually, it is not hard to find that the status qua of a university laboratory is quite similar to the manufacturing zone of an enterprise. In general, many laboratories have not rational layout, where the equipment, experimental materials, personal effects and office furniture are disorder. The wastes and consumables are not disposed properly. These become hidden trouble for experimental education and laboratory management. Under such circumstances, the teachers would not be zealous in performing their duties and the students would not keepdiscipline. Whether the teachers or the students could not devote to work, and then it is impossible to improve the education quality.

TWO STEPS TO REFORM THE EXPERIMENTAL EDUCATIONAL MODEL

The implementation of the reformed educational model contains two parts. Shown as Figure 2, inone respect, we apply 6S management model to organize this experimental course, so as to promote the experimental conditions, and the course would be regularly carried out. In the other respect, we hold a robot competition to evaluate the learning effect instead of the traditional examination method.

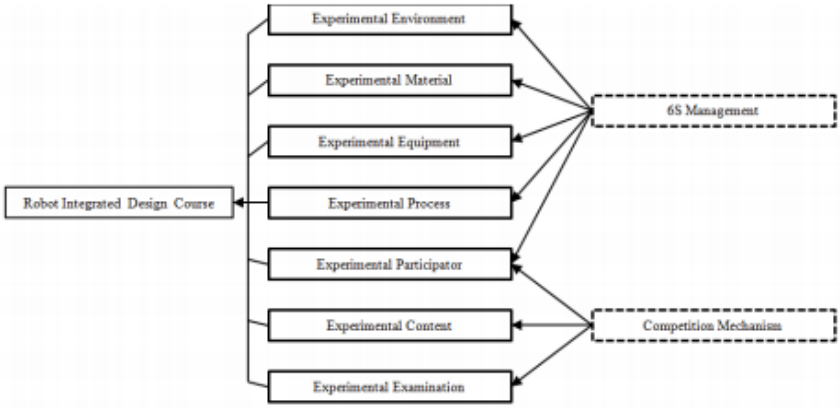

Figure 2 Education Model Based on 6S Management and Competition Mechanism

Applying 6S management model in the experimental course 6S management model is applied in the experimental course. The details include the followings.

Reorganization (SEIRI)

In the course, the students are required to keep the laboratory neat and tidy, and all the things that have nothing to do with the course are not allowed into the laboratory. Thus, it leads to higher work efficiency and lower operating error rate.

Consolidation (SEITON)

All tools and components of the robot car should be in order, and the tools should be returned the back after use. Especially, in the course, although only two classrooms are arranged for 42 students, we manage to take the advantage of the corridors and halls of the experimental building as our testing and running field. The rational overall arrangement for assembling, testing and running makes the students not interfere with each other.

Cleaning (SEISO)

In the experimental site, all garbage, dust and dirt should be removed, and then it can help us notice something abnormal in neat and bright working conditions. Cleaning is very important to work efficiency, safety and health, and it also affects the students' initiative.

Safety (SEICURITY)

Safety is momentous in the course. There are two aspects of safety, one is personnel safety, and the other is equipment safety. Construction of safety system can help us improve safety management level and prevent accidents. All the teachers and students should reinforce the concept of safety and raise safety awareness of working. In experiment, we have some specific security safeguarding measures.

Clearing (SEIKETSU)

The purpose of clearing is fully maintaining the effects of 4S management mentioned before, and it actually focuses on the systematization, regularization and standardization of reorganization, consolidation, cleaning and safety.

Attainment (SHITSUKE)

The significant aim of 6S management is to train attainment of people. In the course, the students are divided into groups, and each group has three students. We demand that theymust be both individual effort and mutual help.If every teacher and student has good studying and working habit, and they all strictly abide by the rules and regulations, the teaching activities would be carried out smoothly and the students would benefit a lot from experimental courses.

Applying evaluation system based on competition mechanism

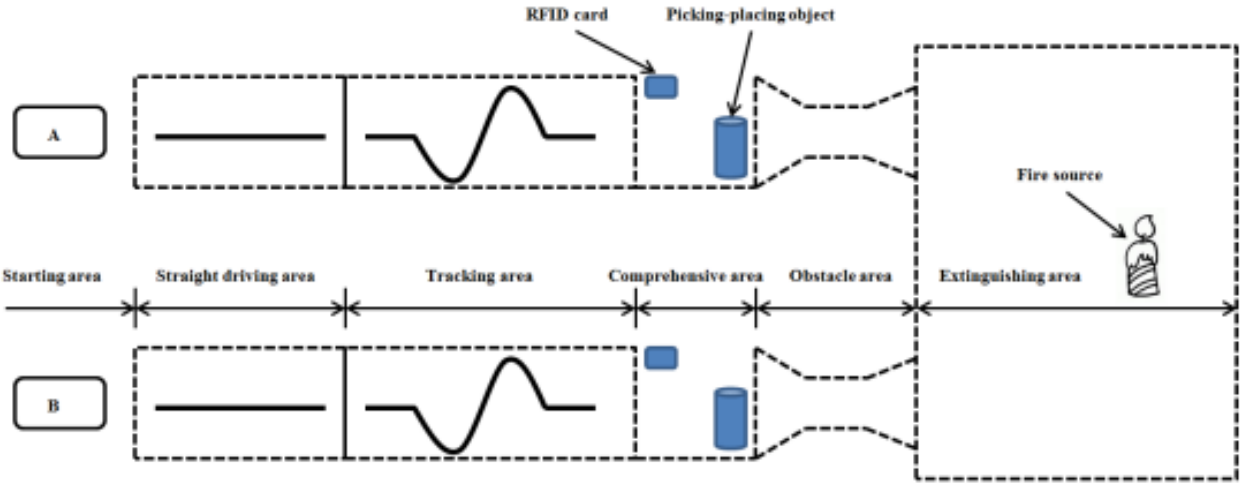

Figure 3 Diagram of Competition Field

Modern education is highly technical dependent and this has redefined teaching learning process(Nadire Cavus, Muhammed Sharif, 2014).Inthecomprehensiveassessment of the design, drawing on the experience of ROBOCON Robot Competition Rules, we hold a class competition and demand that all the students need to join it. Several contest scenes are set to combine the experimental items, which are close to engineering practice. The competition results would be one of the fundamental evaluation indexes.

Figure 3 shows the diagram of competition field where is consist of racetrack A and B. Each racetrack has starting area, straight driving area, tracking area, comprehensive area, and obstacle area and extinguishing area. A straight line and a curve have been respectively drawn in the straight driving area and tracking area. The RFID card and picking-placing object are placed in comprehensive area. A burned candle is placed in extinguishing area as fire source. The competition rules can be summarized as follows. An elimination system is adopted here, the one who has accomplished all tasks and quickly extinguish the fire would win and move on to the next round, till the champion has crowned.

CONCLUSION

The primary goal of this research is to explore how to organize and manage the experimental course of robot-integrated design. In this paper, the author presents a new education model based on 6S management model and competition mechanism. After applying it to practice, the laboratory environment has been improved and gains praise from the teachers, students and managers. In the course, the students show more learning initiative and exploring spirit. Their practical abilities are evidently promoted. They approve that what they have learned from this course provide intellectual support for their success in electronicdesigning competition and graduation design. The following conclusions are drawn. Firstly, it reforms the management mode of laboratory and upgrades the management level of laboratory. Next, it improves the teaching quality and it gives us a successful example of arousing the students' interests on learning. Finally, it promotes cultivating creative spirit,practical abilityand cooperation consciousness of university students. Future work will focus on how to popularize the experience of the course reformation to other courses.

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