Research on Software Testing Technical Ability Training based on e-learning

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ABSTRACT
Software testing is an important part of Software Quality Assurance. Improving the testing technical ability of software testers is the goal of software testing teaching. Based on e-learning and CDIO education model, this paper proposes a test technical ability training mode integrating courseware resources, exercise environment and training activities, which changes the status of traditional software testing course teaching which emphasizes theory over practice. Teaching practice has proved that the new training method can improve students' interest in learning and effectively promote the training of students' ability of software testing.

CCS Concepts
• **Applied computing** → **E-learning**

Keywords
Software testing; e-learning; test technical ability; online training platform

1. INTRODUCTION
Software quality refers to the degree to which software is consistent with clearly defined and implicitly defined requirements. Software testing[1~3] is the final review of software requirements analysis, design specifications and coding before the software is put into operation, which is the key step of Software Quality Assurance. As a result, the status and role of software testing in quality control has become increasingly prominent. With the rapid development of software testing industry, most companies have been equipped with full-time testers. However, the development of software testing [4] cannot match the development of software development, because the latter benefits from the development languages, development tools, design patterns and object-oriented ideas, while the former mostly stays in the manual testing stage. On the one hand, the purpose of software testing is to identify the causes and distribution of software errors, to find and eliminate the defects of current software products, to find and fill in the problems in the process experience and ability to find Bug, more on the tester's understanding and verification of requirements, and correct software behavior. On the other hand, software testing discipline lacks strong support from other disciplines, such as the application of mathematics and artificial intelligence, and testing tools need to be further improved. Therefore, on the premise of investing test resources and purchasing test tools, it is an urgent problem for software testing industry to pay attention to the training of testers, continuously improve the testing technical ability of testers, and gradually shift from manual testing to automated testing.

In this paper, we study a test technical ability training mode based on e-learning [5~6], which integrates courseware resources, exercise environment and training activities. The structure is organized as follows: Section 2 presents problems in the teaching of software testing. Section 3 introduces e-learning and education model about the method. Section 4 establishes software testing technical ability training based on e-learning. Section 5 concludes the paper and point out further work. Finally, Section 6 presents acknowledgments and Section 7 gives references.

2. PROBLEMS IN THE TEACHING OF SOFTWARE TESTING
The teaching content of software testing course focuses on explaining the basic principles and common methods of software testing. It often focuses on specific software testing methods, such as black box testing, white box testing, software testing based on defect mode, integration testing, system testing and so on, and combines with the current popular software testing tools.

In the teaching method, we adopt the simple theory teaching method, and discuss the lessons according to the texts. The students are passively accepted by teaching. Despite the unremitting efforts of teaching staff, they try to change this situation, but in view of the abstract content of the course, difficult to understand, some teachers themselves lack experience in software project development, and cannot flexibly combine theory with practice in classroom teaching, so they can only discuss the course. As a result, the students who lack the background of software project practice do not have an overall control over the testing process, and they are difficult to understand the abstract testing types and methods. They simply stay at the isolated conceptual level.

Under the traditional teaching, the experiment of software testing course lacks the process management and environment support construction of software testing. The experiment is limited to the explanation of testing tools. The specific practice needs students to digest outside the classroom teaching. Even though some software testing courses have in-class practice hours, the reasons of class hours are usually considered. Usually only for installation

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and simple use, the actual test project is still unable to start immediately. In teaching activities, students can only follow the rules to complete the "steps" of the classroom, lack of practical engineering applications, and feel "dull" in the course of gradual progress. Therefore, the understanding of the curriculum is also incorrectly summarized as "useless" and "impractical". In the long run, the students gradually lost interest in learning the course, and eventually expressed their "fear of difficulties" and unwillingness to learn emotions in the learning process. As a result, the final teaching effect is unsatisfactory and the teaching quality cannot be guaranteed. In addition, considering that there are obvious differences in students' source, learning ability and computer skills, it is not appropriate to adopt "one size fits all" teaching methods based on the syllabus to improve the overall teaching quality. Therefore, in recent years, the author's team has been trying to integrate courseware resources, exercise environment and training activities based on e-learning, changing the status quo that traditional software testing teaching emphasizes theory rather than practice.

3. E-LEARNING AND EDUCATION MODEL

3.1 E-learning

Learning Managed System (e-learning) is an online learning system. It teaches and learns online in a virtual classroom through computer Internet or mobile wireless network [7]. Therefore, it is often referred to as network training platform, online education system and so on. It mainly includes courseware release management, online courseware management, learning materials management, online examination management, report analysis management, learning community management, external interface management and role management.

Using e-learning in software testing teaching can effectively use modern teaching methods to complete high-intensity and difficult-to-understand technical content teaching and learning. It can expand 45 minutes of classroom into more 45 minutes. It can turn the stubborn classroom into an online broad classroom, and realize the dual extension of time and space fields.

Specifically, for teachers, e-learning can enrich the teaching means of software testing course, expand the audience, reduce the burden of teaching work to a large extent, and improve the level of teaching management. e-learning can set up teaching courses according to time, place and person. At the same time, it can dynamically adjust teaching content and teaching form according to the actual teaching situation. The platform can record data in the teaching process and form teaching database. Then, through statistical function, it can effectively evaluate both teaching and learning, and realize the quantification of teaching effect.

At the same time, e-learning can provide a variety of test practice operation opportunities, can be connected with the popular "MoocTest" and "AllTesting" platforms, and effectively use the modern means of network, with the help of "National College Students Software Testing Competition" and other opportunities, to increase learning opportunities for students, so that students' personalized learning can achieve higher retention. Strengthen the communication and cooperation between teachers and students, students and students, and be able to arrange the study time reasonably according to their own situation in peacetime. It can make the "insufficient" eat enough, and enable the "poor households" to make use of their spare time to improve themselves and catch up with themselves. Finally meet the needs of students at all levels.

3.2 Education Model

CDIO (Conceive-Design-Implement-Operate) [8] is the latest achievement of international engineering education reform in recent years. Since 2000, the Swedish Charms Institute of Technology, Linkpin University of Sweden, Massachusetts Institute of Technology, Royal Swedish Institute of Technology and four universities have made transnational research, which has received nearly 20 million US dollars from the Knut and Alice Wallenberg Foundation. After four years of exploration and research, the concept of CDIO engineering education has been established and an international cooperative organization named after CDIO has been established. Its goal is to express the needs of enterprises in terms of basic principles of engineering. It emphasizes that while strengthening basic education. It pays attention to engineering practice, strengthens practical links, and advocates that both individual vocational skills and interpersonal communication skills should be emphasized. Emphasis is placed on comprehensive innovation capability. CDIO engineering education model experience at home and abroad shows that CDIO is advanced and feasible, and it is suitable for the reform of various links in the teaching process of engineering education. Therefore, it introduces CDIO engineering education model into software testing course teaching. Software Testing Technical Ability Training on e-learning is supported by CDIO theoretical model, which effectively solves the problems existing in teaching practice.

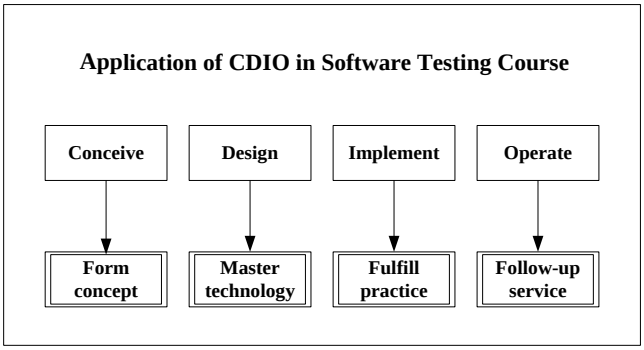

Figure 1. Application of CDIO in software testing course.

The theoretical basis for solving problems in software testing course teaching is CDIO engineering education model. The Conceive, Design, Implement and Operate links involved in CDIO can be effectively implemented by e-learning, namely online training platform. In the course of teaching, the task of software test design is taken as the orientation, and the main goal is to cultivate the ability of test technology, team cooperation and practical ability. As shown in Figure 1, by using a comprehensive training method of collecting network resources, the students can achieve the predetermined ability training goal at four levels: Form concept, Master technology, Fulfill practice and Follow-up service, so as to make Europe and the United States take the lead. The advanced concept of engineering education reform can be inherited and applied. The premise of developing software testing ability based on e-learning under CDIO theory is the integration of theory and practice. The carrier is the software product testing process, which enables students to learn software testing and improve testing ability in an active, practical and organic way. Combining the CDIO engineering education model with "learning by doing" and "project-based education and learning", the supporting educational reforms are as follows:

Firstly, reform teaching organization and combine theory with practice. The teaching process combines theory teaching with task experiment, and no longer distinguishes theory class from practice class. Typical software testing projects are selected as task experiments. According to curriculum standards, the projects are divided into several independent special tasks corresponding to classroom theoretical teaching.

Secondly, innovates the course "actual combat" and attach importance to engineering and team. Setting up integrated project practice to simulate the actual test project, so that students can understand the whole software development process and deepen the test consciousness at the same time. The project practice takes the project group of students' free combination as the unit, and the process of completing the project cultivates the team spirit and the ability of pioneering and innovating.

Thirdly, introduces new teaching technology to realize data-feeding teaching. With the help of e-learning and other modern teaching technologies, the process data can be automatically recorded, and the data generated in the course of teaching can be analyzed and excavated in depth. From the perspective of teaching, teachers can help them grasp students' learning situation in time and adjust teaching plans reasonably. From the perspective of "learning", students are encouraged to construct a learning system that conforms to their own characteristics based on valuable information brought by data.

Fourthly, constructs a comprehensive evaluation system and strengthen the ability orientation. We should change the traditional examination and evaluation system which focuses on theory, increase the proportion of practice assessment, and construct a comprehensive evaluation system of "theory - task experiment - project practice - innovation", so as to effectively evaluate the actual situation of curriculum learning and promote the cultivation of students' test ability and the formation of innovative spirit.

4. SOFTWARE TESTING TECHNICAL ABILITY TRAINING BASED ON E-LEARNING

How to improve the tester's ability of software testing technology? In the training process of software testing technical ability, the dependence on professional testing courseware and testing exercise environment is very great. Without training platform, it is difficult to organize the training of testing skills effectively and systematically for learners, and it is difficult to accumulate the professional knowledge and courses of testing, which will affect the further improvement of testing service ability and level.

4.1 Online Training Platform

The author's teaching team has been devoted to the construction of online training platform for software testing since 2012. The overall design of online training platform system is shown in Figure 2. It is mainly divided into system portal, educational administration, white box testing ability training, performance testing ability training, security testing ability training and virtual testing environment (Desktop Cloud Platform) and system management.

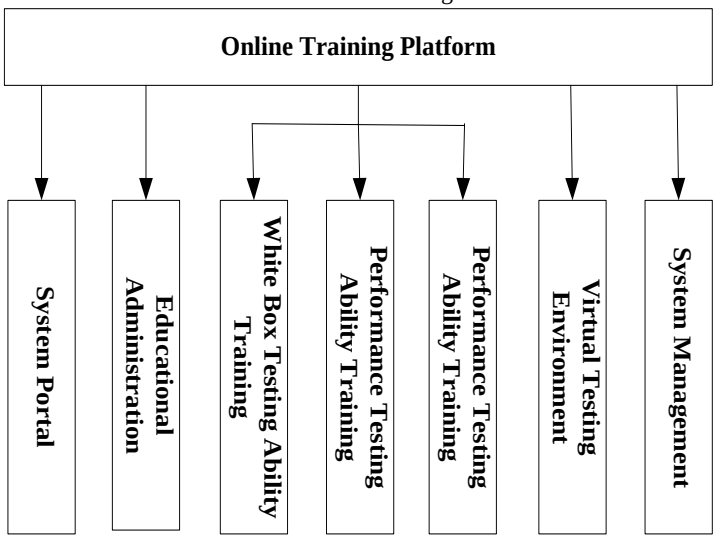

Figure 2. Online training platform.

The system portal displays a unified platform for training and learning environment through web pages. The educational administration manages announcements, classes and evaluation statistics in the teaching process. The white box testing ability training designs and completes the teaching, learning and examination functions according to the characteristics of the visual testing method of white box testing. Students can quickly understand the program structure and processing process, according to the program internal logic test procedures, check whether each path in the program works correctly according to the predetermined requirements. The performance testing ability training is designed to complete the teaching, learning and testing functions according to the performance test objectives, so that students can exert pressure on the system under test in a specific way according to a certain strategy to obtain performance indicators such as system response time, TPS (Transaction Per Second), throughput, resource utilization and so on, so as to ensure that the performance of the production system can meet user needs. The training of security testing ability completes the teaching, learning and testing functions of security testing ability training around the function of security testing, so that students can find out the potential security risks in software programming and check the application program's ability to prevent illegal intrusion. According to the security indicators, different testing strategies are different. The system management completes the

management of the organization, users, privileges and roles of the whole system.

As shown in Figure 3, the cloud desktop system provides a cloud desktop practice environment for testing training, and supports data exchange of training and assessment results. Practice and examination in online training platform are divided into theoretical and practical questions. Students can answer the theoretical questions directly in the system. For the test questions operated on the computer, the system automatically links to the virtual test environment. The environment provides test codes, test tools and so on. Students can operate on the computer in the virtual test environment. The virtual training environment in the platform adopts cloud desktop platform products. Cloud desktop is a desktop virtualization product based on VDI. It can realize the virtualization of desktop IT system. It allows users to centralize all virtual desktops and their application systems into the background server.

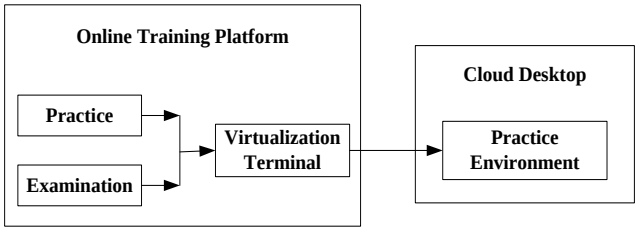

Figure 3. Cloud desktop system.

4.2 Test Technical Ability Training

As shown in Figure 4, based on the online training platform, the training of test technology ability focuses on the training platform, which integrates courseware database, exercise environment and training activities. From the perspective of combining theory with practice, this paper tries to continuously improve the teaching ability of test technology training, so as to lay a foundation for the testers in training organization and skills training.

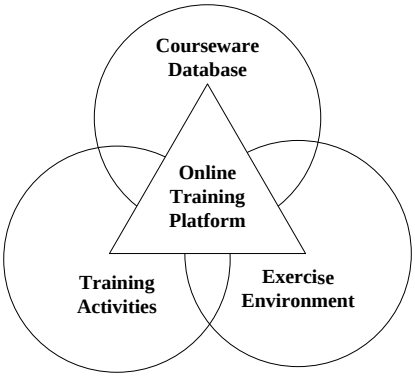

Figure 4. Test technical ability training.

As shown in Figure 5, objects of online training platform involves administrators, teachers and students. Teachers organize teaching courses according to the platform, such as code review and static analysis test training module, system performance test training module, security test module, etc., and establish corresponding course content, test and drill environment on the platform. Students conduct course learning, test simulation training and skills testing based on the platform. With the help of online training platform, teaching activities such as learning, training, practice, communication, teacher counseling, examination and statistical analysis can be carried out online. At the same time, it can also satisfy the functions of training management, organizing examination, training, achievement statistics and performance appraisal of teaching managers, so that managers can impartially evaluate the quality of students.

The courseware database management is designed around the courseware material. The course resources are all input and managed by administrators. The course resources can be classified and managed. The courseware can be retrieved according to the query conditions. The content of courseware includes texts, pictures, video, audio, flash, web pages, files and so on. Once the courseware is entered and created, the administrator can grant the courseware to the newly established class. The teacher can integrate his own courseware library through the selection of the courseware library in the course organization module. Of course, the courseware library can also be optimized according to the teaching experience. The newly added resources can be transferred to the library by submitting the application for approval, and the courseware library can be optimized by submitting the application for approval. The improvement of the original resources is transmitted to the warehouse by submitting applications for approval. Obviously, with the continuous development of curriculum training, the courseware library has been gradually optimized and expanded.

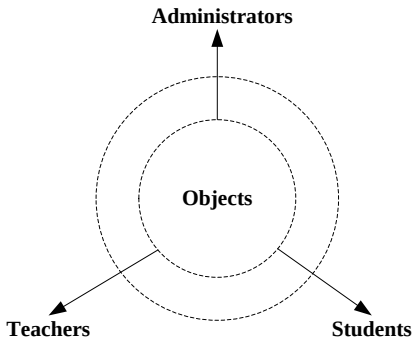

Figure 5. Objects.

Training activities and exercise environments revolve around training and practice of white box testing ability, system performance test ability, and safety test ability. Teachers can publish training cases online, students can obtain cases, and can submit, feedback and share training results at any time after training in practice environment. Aiming at the training and practice of white box testing ability, the online training environment and interactive means of code review, static analysis and logical testing ability are constructed, and the simulation environment of typical development language about white box testing training is provided. According to the training and practice of system performance testing ability, three typical performance testing target environments are provided for students to simulate operation. Aiming at the training and practice of safety testing ability, the simulation environment of system safety testing training is provided. On this basis, other types of test ability training and practice activities can be expanded in the future.

5. CONCLUSIONS

Every software development processing requires testing, which ensures program quality, validation and validation, or reliability evaluation [9], so as to ensure customer's requirement,. At present, the level of domestic testers is generally low, especially in the

design ability of test cases, the standardized execution of tests, automated testing and performance testing. This is also related to the late start of the testing industry and the lack of experience of testers. In order to change these situations, it is necessary to tightly link the organization and management of the testing process and improve the testing technical ability of testers. Relying on the Military Training Software Evaluation Center and the advantages of military academies, the author's testing team has been devoting itself to the research of the training of testers and the teaching of software testing courses in universities, trying to put the teaching concept of combining theory with practice throughout the course. The training of test technology ability based on online training platform proposed by the team has prominent operational characteristics and strong pertinence. Students can experience the practical application of theoretical knowledge in the course of practical training. Such teaching can make the traditional boring theory teaching "live" and effectively stimulate students' interest in participating in the test. It can achieve the teaching goal of putting learning into practice.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] Myers, Glenford J., Badgett et al. 2012. *The Art of Software Testing (Third Edition)*. China Machine Press, 124-132.

[2] Ilene, B. 2010. *Practical Software Testing: A Process-Oriented Approach*. Springer, 215-216.

[3] Rom, P. 2006. *Software Testing (Second Edition)*. China Machine Press, 103-105.

[4] Nengji, C. 2011. Software Testing Guide: Fundamentals, Tools and Practice (Second Edition). China Posts & Telecom Press, 89-95.

[5] Brenda, S. 2002. Performance-Based Instructional Design For E-learning. *Performance Improvement*, 41, 7, 45-51.

[6] Chittaro, L.， Ranon R. 2007. Web 3D Technologies in Learning, Education and Training Motivations, Issues, Opportunities. *Computers & Education*, 49, 1, 3-18.

[7] Baidu Wikipedia. *E-learning platform*. (2019-02-09)[2018-01-18].https://baike.baidu.com/item/e-learning platform/2565966?fr=aladdin

[8] Baidu Wikipedia. *Cdio*. (2019-02-09)[2018-12-15]. https://baike.baidu.com/item/cdio/4644769?fr=aladdin