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Planning and Design of Personalized Dynamic Assessment for Linux Learning

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Abstract: This study aims at the development of a personalized dynamic assessment system for Linux learning. The proposed system is divided into three major components, including learning materials, learning resources, and dynamic assessment. After assessing learners' learning states and performance, the proposed system can instruct learners to use appropriate learning materials and resources as feedbacks to complete the given tasks, so that learners can use correct Linux commands with the right syntax. These feedbacks can improve learners' operability on Linux, and can enhance learners' motivation and interests. To well develop the proposed system, the three major components will be reviewed by experts through heuristic evaluation and by users through System Usability Scale (SUS). This paper is to describe the issues of planning and design of our personalized dynamic assessment system. The processes of expert and user evaluation for the proposed system are also discussed.

Keywords: Dynamic assessment, Linux, learning materials, system usability scale (SUS)

1. Research Motive and Purpose

Assessment plays an important role in teaching/learning activities. If teachers can properly perform assessment in their teaching activities, learners' learning performance will be significantly improved. Traditionally, the teaching of Linux takes place in class or at a computer room. Most of teachers type text-based commands one by one on the terminal with a command-line interface, while giving some introduction to the commands. After that, leaners practice these commands on their terminals. For those learners used to operate computers on graphical user interfaces (GUI), such as Windows or Mac OS, the function and syntax of a text-based command of Linux may be difficult to understand. As a result, the learners usually use Linux commands through rote memorization. They don't know how to use the command correctly and may not realize the system architecture and the operation process of Linux. Eventually, the learners may lose their interests and confidences on learning Linux.

Dynamic assessment is a technique of using interactive assessment to understand the learners' learning needs and outcomes. Dynamic assessment can also give learners some feedbacks and then encourage learners to perform the given tasks. Unlike traditional Linux teaching, this study aims at the development of a personalized dynamic assessment system for Linux learning. The main concept of the proposed system is to provide dynamic assessment when learners operate the system to learn Linux. After assessing learners' learning states and performance, the system can provide personalized feedbacks, namely learning materials and resources, to enhance learners' operability on Linux, and thereby to help learners to achieve effective learning performance.

In this study, the proposed system is divided into three major components, including learning materials, learning resources, and dynamic assessment. The learning materials further consist of six learning modules that are designed according to traditional materials for teaching Linux. The learning resources are technical documents on the Internet. These documents are classified and aligned according to the six learning modules; learners can read the documents to know how to operate Linux. Dynamic assessment can assess learners' learning states and performance and provide appropriate learning materials and learning resources as feedbacks to learners.

2. Literature Review

2.1 Dynamic Assessment

Dynamic assessment is “graduated prompting assessment” and was proposed by Campioe and Brown (1987). It is based on the idea of Zone of Proximal Development (ZPD) (Vygotsky, 1978). ZPD refers to the situation when learners accept the help of others such as teachers or classmates, they can perform beyond their current level. The dynamic assessment is a technique of interactive assessment that use standardized instructional support as an intermediary. When learners have problems in learning, dynamic assessment can provide appropriate assistance to improve learners’ achievement by tracking the learning process.

Dynamic assessment is also called as formative assessment, assessment for learning, or ongoing assessment (Derrich & Ecclestone, 2006; Stiggins, 2002). According to Black and Wiliam (1998), formative assessment has four main concepts, including sharing learning goals, questioning, self/peer assessment, and feedback. Formative assessment is a systematic process used to share learning goal and to understand the learners' learning progress. Formative assessment can continue to collect evidence during the learning process; the evidence can be used to identify learners' current level of learning and to guide learners to achieve the learning goal. Furthermore, Black and Wiliam (2009) proposed that formative assessment includes five key strategies as follows:

engineering effective classroom discussion, questions, and learning tasks that elicit evidence of learning;
providing feedback that moves learners forward;
clarifying and sharing learning intentions and criteria for success;
activating students as owners of their own learning;
activating students as instructional resources for one another.

2.2 Heuristic Evaluation

Heuristic evaluation is an informal usability analysis proposed by Nielsen (1994). This analysis requires three or more experts to evaluate a system or an interface through their self-expertise. When the analysis is completed, these experts can discuss with others and provide solutions. The advantage of this analysis is low cast and short time. Heuristic evaluation is to identify the usability problems in a system or on an interface according to ten indices, including visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize, diagnose, and recover form errors, and finally, help and documentation.

2.3 System Usability Scale

System Usability Scale (SUS) was initially proposed by Brooke (1996) when he was at Digital Equipment Corporation. SUS is a commonly used and freely distributed questionnaire that consists of ten indices; it uses a five-point scale with anchors from “Strongly Agree” and “Strongly Disagree.” The ten indices are developed according to the three usability criteria defined in the ISO 9241-11, including

effectiveness: the ability of users to complete tasks using the system and successfully achieve their objectives;
efficiency: how much resource is expended in achieving those objectives;
satisfaction: the users’ immediate reactions using the system.

SUS is an effective and reliable tool for measuring the usability of systems and services, such as hardware, software, mobile devices, websites, and applications.

3. System Planning and Design

The proposed system is divided into three major components, including learning materials, learning resources, and dynamic assessment. The learning materials and learning resources are designed by professional Linux teachers; and the conceptual model of the proposed system is shown as Fig. 1. The learning materials also consist of six Linux learning modules, including User Account/Group Management, System Management, File System, Firewall, Apache, and FTP. The six modules are designed according to traditional Linux teaching materials, which refer to the chapters of "Basic learning about Linux OS" (Tsai, 2010) and "Server learning about Linux OS" (Tsai, 2011) and other related topics such as Linux Disk and File System Management, Account Manager and ACL, Crontab, RPM and SRPN, Internet, Firewall and NAT Server, Apache Server, FTP Server, and so on. The above topics are suitable for beginners. The six modules deal with the overall processes of implementing Apache and FTP server. The learning resources are technical documents on the Internet. These technical documents are written by many online users according to their experience of operating Linux; in this study, the documents are classified and aligned according to the six learning modules so that learners can read the documents for the usage of Linux commands. When learners finish each of the six learning modules, dynamic assessment can assess learners' learning states and performance and then provide appropriate learning materials and learning resources as feedbacks to learners. These feedbacks can guide learners to complete the implementation of Apache and FTP server.

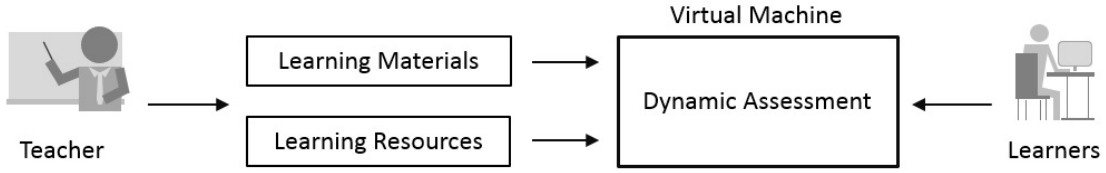

Figure 1. Conceptual model.

The proposed system is packaged with Linux OS in a virtual disk image. After installing a virtual machine on a computer and restore the virtual disk image, learners can practice learning materials and learning resources in an actual Linux environment after class, at any time and any place. In the meanwhile, learners can practice how to plan and manage their virtual Linux environment. In this study, the version of Linux OS is CentOS. When the virtual disk image is restored, CentOS will start up in the virtual machine, as shown in Fig. 2. Afterward, learners can practice the six learning modules through operating CentOS. When learners finish each of the six learning modules, the proposed system can provide the assessment results of the completed module, as shown in Fig. 3. The proposed system provides the appropriate learning materials and learning resources as feedbacks. According to the feedbacks, learners can continue to practice the six learning modules until all practices are correct. When learners finish each of the six learning modules, they can use the function of virtual machine snapshot to quickly restore their Linux environment and then practice again, as shown in Fig. 4. Therefore, learners' operability in Linux OS will be improved.

In summary, advantages of the proposed system are as follows.

Dynamic assessment is used to assess the learner's state and performance according to the text-based commands used by learners. When learners operate the proposed system, the system will provide appropriate learning materials and learning resource as feedbacks to learners and to guide them to realize the correct process and steps of implementing Apache and FTP server.

The feedbacks provided by the proposed system can be used to understand the learners' learning need and outcomes and help learners to achieve effective learning performance on Linux.

When learners finish each of the six learning modules in the virtual machine, they can use the function of virtual machine snapshot to quickly restore their Linux environment and then practice again.

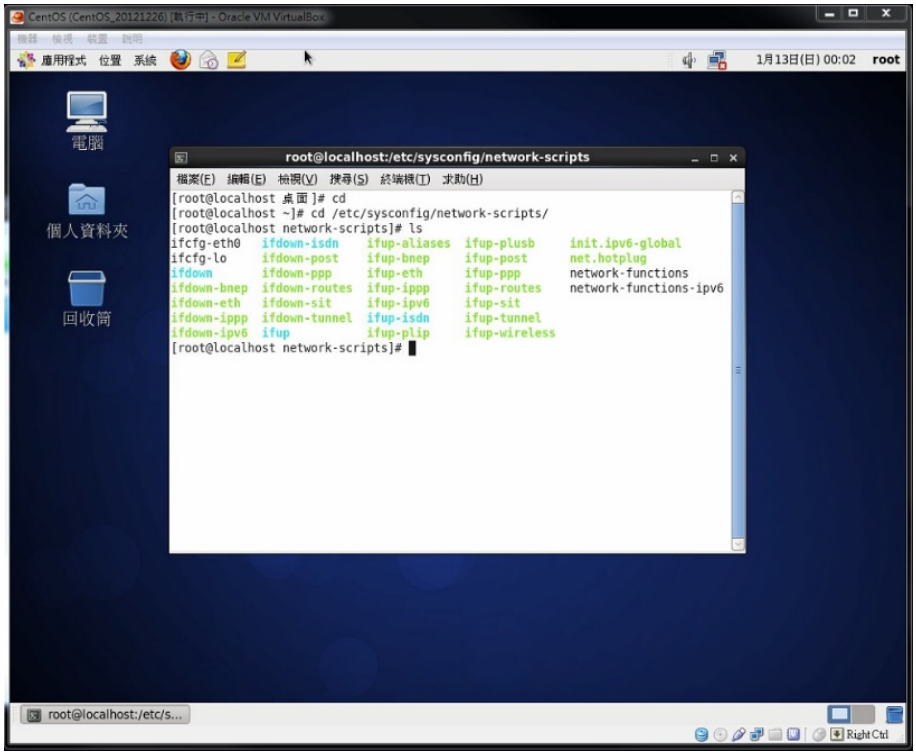

Figure 2. CentOS in the virtual machine.

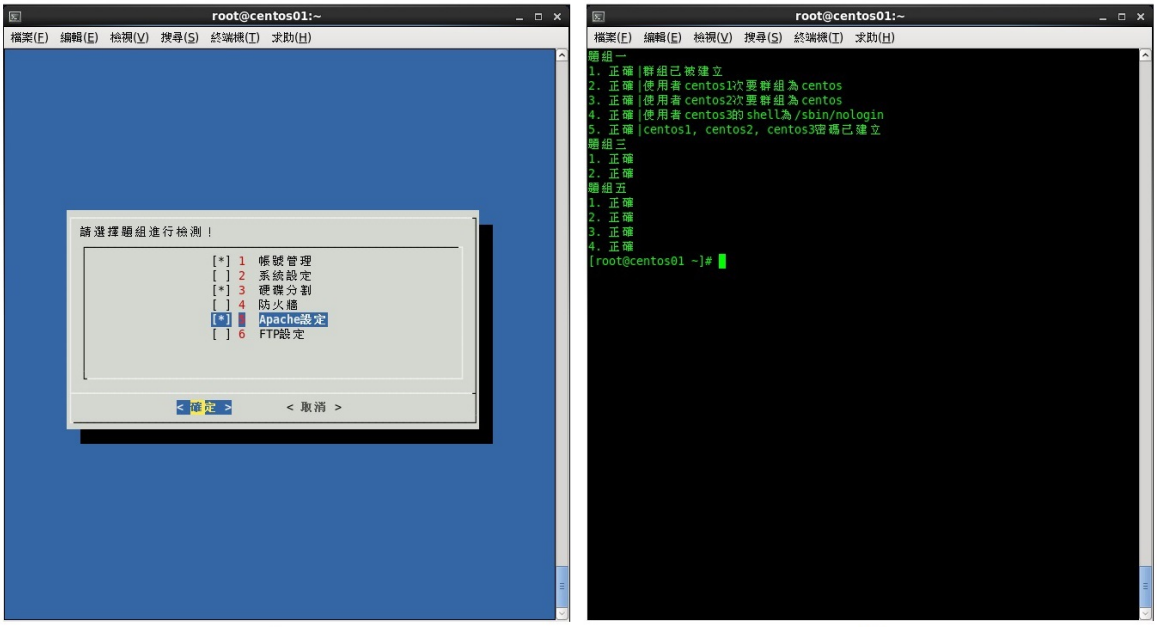

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Figure 3. Screenshots of the proposed system. (a) The learner selects the completed module for assessment. (b) The system provides the assessment results.

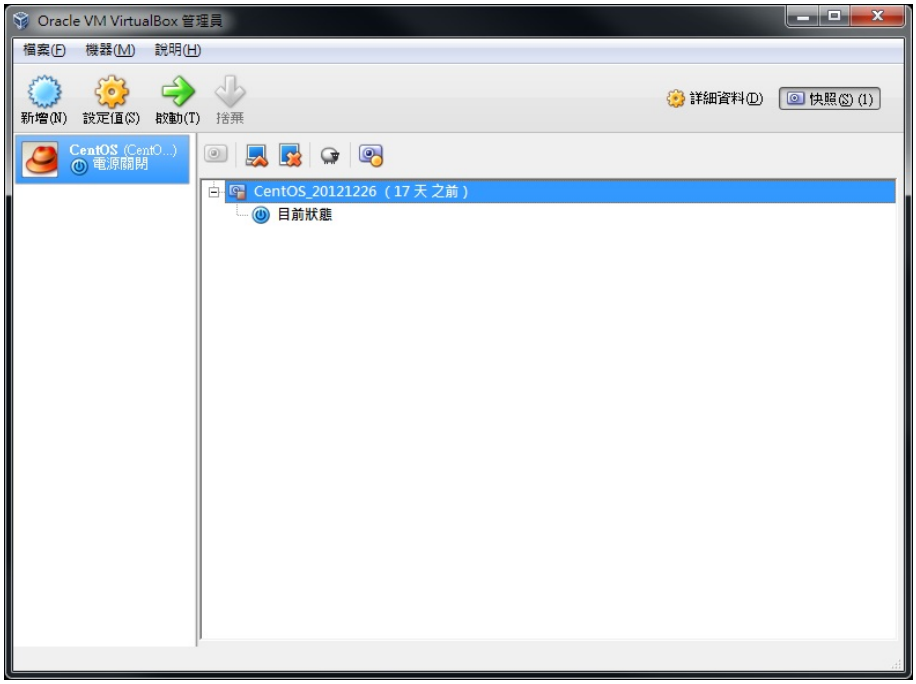

Figure 4. A virtual machine snapshot

Learners can practice the six learning modules through an actual Linux environment after class, at any time and any place; their learning process will be recorded in a system log. After the analysis of the system log, the personalized assessment results will be provided to learners.

In this way, learners can find out their operational or conceptual mistakes through the personalized assessment results and try to compensate for the Linux problem-solving capability they lack; their operability in Linux OS can be also improved.

4. Expert and User Evaluation

4.1 Heuristic Evaluation

The proposed system will be reviewed by experts through heuristic evaluation (Nielsen, 1994). The experts will be asked to follow the ten indices one by one to evaluate the system and to identify the usability problems of the system. The process of heuristic evaluation is as follows:

Domain experts are invited to join the evaluation.

The authors introduce the system and its interface so that experts can well operate the system.

Based on the ten indices, each expert reviews the system individually by her/his expertise.

For each index, the expert must identify the usability problem of the system and write down the reason or a solution, if necessary.

When the evaluation is completed, the experts discuss with others and provide the solution to improve the proposed system.

4.2 System Usability Scale

The proposed system will be also reviewed by users through the use of System Usability Scale (SUS). SUS has ten indices to measure users' subjective evaluation of the system usability. As mentioned before, the measurement results are three-fold, including effectiveness, efficiency, and satisfaction of the system. The use of SUS is as follows:

Users are invited to join the evaluation. The users are graduate and undergraduate students of Computer Science.

The authors introduce the system and its interface so that the users can well operate the system.

Based on the ten indices, each user reviews the system individually by her/his experience.

After reviewing the system, the user starts filling the questionnaire by her/his subjective perception. The questionnaires are analyzed through various statistical methods; the analysis results will be reported and used to improve the system.

5. Conclusions and Future Works

A personalized dynamic assessment system for Linux learning is proposed in this study. The proposed system is divided into three major components, including learning materials, learning resources, and dynamic assessment. The learning materials further consist of six learning modules that are designed according to traditional materials for teaching Linux. The learning resources are technical documents on the Internet; they are classified and aligned according to the six learning modules so that learners can read the documents for the usage of Linux commands. The learning materials and learning resources are designed by professional Linux teachers and are suitable for beginners. To achieve the goal of personalization, dynamic assessment can assess learners' learning states and performance and then provide appropriate learning materials and learning resources as feedbacks to learners. These feedbacks can guide learners to complete the implementation of Apache and FTP server.

The proposed system is now in its prototyping stage. This paper is to describe the issues of planning and design of our system. The processes of expert and user evaluation for the system are also discussed. In the near future, heuristic evaluation by experts and SUS by users will be performed to identify the potential problems of the system. After that, the identified problems must be effectively solved to achieve the goal of truly personalized dynamic assessment.

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