Research on Remote Collaborative Engineering Practices for Master of Software Engineering based on Cloud Computing Environment

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Abstract

This paper describes the development and implementation of a cloud computing-based remote collaborative system for performing practices in basic IT software engineering courses. In cloud computing environment, the features of remote collaborative engineering practices is not only the abundant resources sharing. The development of virtual laboratory provides users virtual software development environment. Anyone can upload code and run it in this virtual environment. More important, students can authorize his team member, such as an expert, to debug their code remotely. A web interface provides these students visual debug process dynamically. Finally, we discuss the experience gained from this project with the hope of being a reference for others in the IT education community.

1. Introduction

How to enhance the practical project development ability of students is one of the key considering for software engineering master's education. Since these students are often spread throughout the country, and most of the IT practice courses need to change content quickly according to the rapid pace of IT technology, traditional single teacher-single classroom teaching model is very unsuitable for this case. A new teaching model which supports remote self-learning and collaboration is needed. With the rapid pace of network technology, remote teaching was applied in few schools before 2005 in China. Many related studies can be found for these years, some are theoretical analysis about the general pattern of remote teaching [1][2], some focus on the application of a variety of network tools such as web site, blog, forum from the technical point of view[3][4]. However, in these studies, so-called network teaching can be considered as only the implementation of resource sharing in some degree, such as book, and video, etc. Students study knowledge passively. This teaching model is teacher-centered and not favorable for IT engineering practice courses, in which the collaboration between students and teacher is promoted, and active learning is needed.

In this paper, a novel remote collaborative engineering practices model is presented. The rest of this paper is structured as follows. In section 2, the related work is introduced. We analyze all requirements of an IT engineering practice course and classify different roles within all participants in the activities in section 3. In section 4, the suggested system model is discussed. We show the detailed implementation steps in section5. The final section summarizes the paper.

2. Related work

The comparative analysis of the most popular e-learning systems in respect of their use in a teaching process was made in [5]. We also investigate the application of cloud computing in education project. Discussion about teaching cloud computing in a regular IT course to meet the needs of the industry and its users can be found in [6]. In this paper, authors incorporate cloud computing into the curriculum of undergraduate education for computer systems and network administration through a senior design project. There are also several successful deployments of cloud computing within educational and learning organizations, utilizing both commercial and non-commercial cloud computing solutions [7-10]. A computing paradigm merging volunteer contributing and Cloud approaches into EduCloud@Home in the education project is proposed in [7]. The basic idea is to reuse

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"domestic" computing resources to build voluntary contributors' Clouds in the education application project. In [8], authors discuss how to develop cloud computing technology and apply online video resources for distance collaborative teaching. In [9], the different ways to implement cloud computing are evaluated. As the result, authors present their research and education prototype for education infrastructures between academic institutions. [10] also discusses cloud computing applying in education informationalization. The use of cloud computing in the educational and learning arena, to be called "Education and Learning as a Service" is discussed (ELaaS) in [11], in this paper, a new cloud computing formation model, called the Complete Cloud Computing Formations (C3F), is proposed. Another important factors in widening the scope of web-based e-Learning for engineering disciplines is the development of remote laboratories that can provide practical experience and enhance programming skills of engineering students nearly similar to that gained by performing the experiments in real laboratories. In [12], authors present pre-requests, architecture and software realization of web based laboratory named WebLab which provides remote access to real laboratory equipment using contemporary computer and network technology for creating the environment and how it can be integrated into an e-learning environment. The development and testing of a web-based remote laboratory is also described in [13]. It mainly focuses on basic electrical engineering courses. The digital camera and audio are used to provide the remote user multimedia service. In [14], the practical application of four visualization techniques is described. These techniques can be useful for monitoring and studying online user activity in settings where many thousands of users are involved in web-based educational endeavors.

3. System requirement analysis

3.1 System requirement

We will give the analysis of requirements below if a "good" remote collaborative system for engineering practice courses is implemented.

1) Support self-learning

It is impossible to cover all contents only in the class lectures for an engineering course. For students, it is a learning process to collect class-related information and record their learning activities. For teachers, it is his responsibility to prepare teaching material as much as possible and monitor students' behavior. All these material should be organized carefully focusing on one theme, so students can follow-up discussion in teaching and research activities, and teachers can learn the advantages and disadvantages of teaching activities in order to continuously improve their teaching ability.

2) Support for peer-to-peer coaching

In network collaborative teaching and research activities, the peer-to-peer coaching is much desired, since it can significantly improve the learning efficiency of student.

3) Support for virtual laboratories

Software-based remote virtual laboratories allow the remote user to conduct the experiments in a relatively real laboratory environment by implementing online coding or debug using a web browser, thus provide a more realistic learning experience. For an engineering practice course, it is a very attractive feature, considering expensive software costs, and students with less experience in project development.

3.2 Participants in the Teaching Activities

In this section, we distinguish different roles in one teaching activity.

1) **Teacher**: In traditional teaching model, a teacher is one who imparts knowledge. However, with the rapid change of computer technology, it is very difficult for a teacher to master all related knowledge on the subject

matter that she is teaching. From this point, a teacher would not be able to accomplish everything. She can be considered as a lesson planer, or a good organizer. She is responsible for problem solving and is herself a good communicator and team player.

2) **Expert**: Experts are someone invited to participate teaching activities and give the timely guidance to teachers via CAI systems. These specialists are very familiar with the new technology, and can give not only real-time comments online, but also off-line reviews. They also keep abreast of reflection of teachers and follow the development of teachers. They discuss related issues with teachers and students. They are the bridge of teachers and students. More importantly, they can work together with students to code and debug program in the cloud computing environment. An expert can be an instructor in the cooperated enterprises, a former graduate or anyone who has worked as a senior programmer.

3) **Students**: A student is a learner, or someone who attends the educational course. In this project, a student refers specifically to the beginner who joins the project team in order to improve programming skills.

4. Proposed educational cloud infrastructure

In this paper, we focus on how to execute a remote collaborative engineering practice course for Master of Software Engineering. The creative idea is to provide computing sharing as well as resource sharing in the system. The detailed structure of the proposed cloud computing infrastructure prototype is shown on Figure 1.

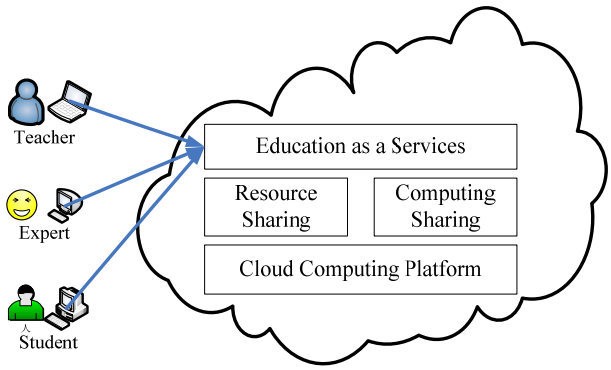

Figure 1. Educational Cloud Infrastructure Prototype

We all know there are three service models of cloud computing. These three service models are Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). In our case, we only assume that by virtualization, hardware level resources are abstracted and encapsulated, providing a flexible infrastructure of distributed data center services. This is the bottom level in our system logical architecture. Based on it, some course-related applications are created and deployed using programming languages and tools supported by the cloud provider. It is the middleware in our system, which mainly includes two types of application services: resource sharing and computing sharing. Resource sharing service provides users synchronous operation to various resource, such as Word file, Excel file, PowerPoint file, PDF file, etc, which are uploaded by remote users. On the other hand, computing sharing service provides a virtual development environment. Anyone can upload code and run it in this virtual environment. At the same time, a cloud-based project management tool is applied to manage the whole life of one project and record all bugs. On the top level, like SaaS, any available application is wrapped as a service, which is accessible by the consumer from various client devices through a thin client interface such as a web browser. We call it Education as a Service (EaaS).

Figure 2 illustrates Educational Cloud infrastructure implementation technology. The end user can access an EaaS through a web portal. The class related scheduler is responsible for aggregating all resources related to this class. The actual work is assigned to two types of nodes: resource management nodes and computing management nodes. The former deal with controlling all documents which are stored into Cloud storage and the later set computing environments for various project teams based on Virtual Computing Laboratory technology. Compared to traditional VCL, in our system, if an end user reserves a seat, the synchronized seats will be arranged to all members in the team, so all members can monitor the process of coding and debugging.

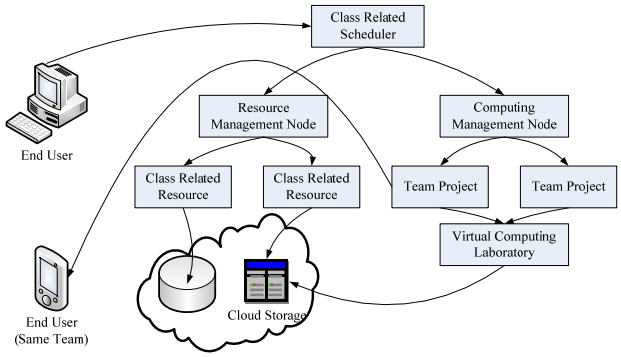

Figure2. Educational Cloud Infrastructure Prototype

5. Implementation steps

First, we strictly define the course in this project belongs to engineering practice course. That means students need to do programming experiments as well as theoretical study. In this paper, we use JavaEE as an example. The chief teacher in this course is from school of software engineering of USTC, who prepare class lectures in the teaching activity. Many specialists from the cooperated enterprises are employed as the expert team, who are distributed to project teams, and responsible for instructing students' practical programming. The who process is divided into four phases: preparation phase, theoretical study phase, practice phase, and evaluate phase.

i. Preparation phase

a) Design syllabus: The chief teacher works together with the expert team to identify the theme of network collaborative teaching. They should list the outline of the course.

b) Prepare resource: The chief teacher uploads class related resources to system, such as: teaching cases, teaching videos, blueprints, courseware, etc. Experts also upload all useful resources in their view.

c) Design teaching: The chief teacher designs his teaching programs independently.

ii. Theoretical study phase

a) Knowledge transfer: The chief teacher introduces the objectives and context of lesson and gives the detailed review of it by chapter in class.

b) Self-learning: After class, students read course-related resources, record their feelings and experiences.

c) Interaction: The chief teacher and experts analyze the students' records and discuss if necessary, then put forward the suggestions. Some problems of the curriculum were answered in the process of interaction.

iii. Practice phase

a) Self-practice: Students are organized to project team with a leader, who is responsible for managing project and assigning work. Members try to write codes respectively.

b) Expert guidance: An expert is delegated to every team. He will take part in the practical programming activities. He can demonstrate how to debug team members' program and track user code dynamically.

iv. Evaluate phase

a) Student comments: Students express their views according to their gains.

b) Expert evaluates: the experts evaluate course and give their commentary on it.

c) Self improve: The chief teacher should communicate with other participants above in the network collaborative teaching, then amend the class syllabus continuously and share the achievements of activities.

6. Conclusion

The new mode of remote collaborative engineering practices system in a cloud computing environment makes the network programming experiment feasible. Using cloud infrastructure, in addition to sharing various teaching materials, such as reference book, class lecture, sample code, etc, between teacher and students, the remote users can also upload their programming code, run and debug program on cloud platform. The cloud-based remote collaborative engineering practices system with the characteristics of virtualization, collaboration, sharing, visualization, provides practical references for engineering practice teaching in future.

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