Remote Sharing Platform Based on Embedded Experiment in Experimental Teaching Reform

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Keywords: Educational Reform, Experimental Teaching, Distance Experiment.

Abstract. This article introduces a remote sharing platform based on embedded experiment, which discusses deeply about the significance of auxiliary teaching tool for the embedded experiment, and the effect of applying it to practical teaching activities. This platform introduces sharing mechanism and automatic appraisal mechanism innovatively. It not only breaks the restrictions of time and space in practical education, improves utilization of experiment equipment, but also relieves pressure of teachers. In addition, through some pilot practice, this platform has acquired acceptance from both teachers and students, which further demonstrates the great practical use of this platform in experimental teaching, points out the direction of embedded teaching reform, and provides guidance for the development of other experiment teaching.

Introduction

Experiment is an important part of teaching process to help students put theory into practice and have ability to solve practical problems. [1] Experimental teaching plays an important role in training high-quality students. Currently, most universities have already offered embedded courses. But as an experiment-based curriculum, in traditional classes, there is not enough laboratory equipment for students to do experiments by themselves. Time and places are limited as well. In the traditional mode of experimental teaching, the laboratory resources are not used efficiently and it is also difficult to motivate students to learn better and to explore more. [2] How to make the embedded-experiment class more effective is becoming a more and more serious problem which teachers are exploring now.

Nowadays, the conception of "Internet+" points out a way of experimental teaching reform in colleges and universities. Doing experiments via the Internet remotely will certainly become the focus of experimental teaching reform.[3] When it comes to embedded experiments, the remote experimental teaching systems that have already existed can't adapt to the embedded experimental teaching that we see very rapidly developing. To explore the practical value of the remote experimental platform for embedded teaching, based on the analysis of colleges' demands for embedded teaching, we have designed a remote sharing platform based on embedded experiment under the guidance of "Internet + education", and have conducted practical pilot teaching to study the significance of the platform in embedded teaching

Introduction of Remote Sharing Platform Based on Embedded Experiment

System Overview

Remote sharing platform based on embedded experiment is an application system on the basis of the real embedded environment. The user conducts experiments by operating the real embedded equipment remotely via the internet. By using time division multiplexing technology and relevant resource scheduling algorithm, at most ten users can share one experiment box at one time.
Automatic appraisal mechanism can provide an objective evaluation of the codes submitted by students preliminarily. The experimental platform positioned as an auxiliary system for the experimental courses improves the utilization of hardware resources of the laboratory, breaks the restrictions of time and space, improves the efficiency of teacher's evaluation and eases the teachers' teaching burden as well.

**Platform Technology Framework**

**C / S Architecture**

![C/S Architecture Diagram](image)

As shown in Fig. 1, client is connected to server via the Internet. Server processes the information sent by client and then modify the database or operate the lab equipment according to the specific information. Student client is used for students to do remote experiments and view the grades. Teacher client is used for teachers to look over the conditions of the students' experiments, meanwhile evaluate the students' experiments on the basis of automatic appraisal given by the system. Manager client is used for manager to monitor the condition of the system.

**System Modules and Experiment Process**

Then various modules of the system will be introduced when a student conducts an experiment. All the information, including users' personal information and experimental records, is stored in the “Database” module. “User Interface” module is for students to access the platform. When the student logs in, the system will check his name and keyword by comparing with the information in “Database”. After system authentication, the student can check tasks teachers arranged and write experimental codes according to the requirement. Once finished, the codes are submitted to the “Server” module via “The Internet”. Next, “Server” asks for the “Scheduler” module to make reasonable arrangement for resource allocation. Then “Scheduler” sends the codes to the “Tornado” module (It’s an IDE (Integrated Development Environment) to assist embedded application development) to compile, after that the compiling result is returned to the “User Interface”. If correctly compiled, the codes are downloaded to the experimental box and run, besides the experimental phenomenon are recorded by the camera. At last, both the running result and experimental phenomena are sent back to the “User Interface”, so students can view the experimental result in a clear and vivid way. What’s more, the compiling and running results are also written into the “Database” module.

Figure 1. C/S Architecture.
Teaching Test on the Platform

Teaching Test Condition

Applying this platform to the embedded experimental teaching for a class with thirty people as a pilot practice achieved an ideal result in the Department of Computer Science, Beijing University of Posts and Telecommunications. This practice lasted for two months. Students had one experimental class per week and one class lasts for two hours. They were requested to finish their experimental tasks by this remote sharing platform based on embedded experiment. Totally, they did four embedded experiments as in traditional embedded-experiment classes.

Resource consumption was listed as follows after using the experimental platform:

<table>
<thead>
<tr>
<th>The number of users that a single experimental box can maintain all at once</th>
<th>At most 10 users can be stably supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ideal number of the experimental box for class teaching</td>
<td>5</td>
</tr>
<tr>
<td>The memory saved by PC when compiling</td>
<td>50%</td>
</tr>
</tbody>
</table>

Take the simple experiment called “Print Hello World” as an example to record the elapsed time when conducting an experiment.

<table>
<thead>
<tr>
<th>Login authentication</th>
<th>Compiling</th>
<th>Download to the experimental box</th>
<th>Check the running video</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1s</td>
<td>&lt;30s</td>
<td>&lt;1min</td>
<td>&lt;2min</td>
<td>&lt;3.6min</td>
</tr>
</tbody>
</table>

The efficiency in the whole mechanism has greatly improved after using the platform
Table 3. Teaching Condition Contrast.

<table>
<thead>
<tr>
<th></th>
<th>Before using</th>
<th>After using</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students' average elapsed time</td>
<td>Fixed hours 4 hours one week</td>
<td>No time limit 10 hours one week</td>
</tr>
<tr>
<td>for the experiment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrators’ average elapsed time</td>
<td>Regularly check all</td>
<td>Regularly check the used</td>
</tr>
<tr>
<td>for the experimental box</td>
<td>experimental box</td>
<td>experimental boxes</td>
</tr>
<tr>
<td>management</td>
<td>1 hour one week</td>
<td>10 minutes one week</td>
</tr>
<tr>
<td>Teachers’ average elapsed time</td>
<td>3 hours one week</td>
<td>1 hour one week</td>
</tr>
<tr>
<td>for evaluating the experiment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The number of the experimental boxes</td>
<td>30 (One experimental box for a</td>
<td>5 (Sharing Mechanism)</td>
</tr>
<tr>
<td>in use</td>
<td>person)</td>
<td></td>
</tr>
</tbody>
</table>

Discussion on the Support the Platform Provided to Embedded Experimental Teaching

High Efficiency
It is seen that the utilization has been greatly improved through the sharing mechanism from the test results. Before using the platform, the small class of 30 people ought to be equipped with 30 fully-functional embedded experimental equipment. After using this platform, the “Server” module can simultaneously connect ten experimental boxes through the switches. Actually, the number of experimental equipment for class experimental teaching has deduced to five after using the platform, just one fifth of the original one. It can be seen that the platform improves the utilization of laboratory equipment obviously, and eases the problem of the laboratory equipment shortage.

Flexible
When students conducted the simple experiment called "Print Hello World" on the experimental platform, the time consumed during the whole experiment process was just four minutes, indicating that it has high transmission efficiency. In that case, the students can conduct experiments at any time and any place, which breaks restrictions of time and space in traditional experimental teaching. The platform arouses students' enthusiasm for teaching. Good using experience enables students to spend more time on the experiment.

Intelligent
The experimental platform can make automatic appraisal for some embedded experiments, while supporting further artificial judgment. The time for the teacher to evaluate experiments reduced to one hour per week, just one third of the original one. It can be clearly seen that the platform relieves pressure of teachers and improves the efficiency of experiment evaluation. What's more, the time for an administrator to maintain experimental boxes reduced to 10 minutes a week, one sixth of the original one. Therefore the platform reduces the workload of the administrator significantly.

Physical Visible
In contrast to traditional virtual simulation platform for experiments, the system can burn the successfully compiled codes into experimental box and run it. The system sends the video of the running result back, and students can see the experimental result directly. The way to display the experimental result has the characteristic of real-time presentation and authenticity, which can bring more impressive and realistic experiences to students.

Robust
Remote experiment platform is very stable when it's running. In case of accidents during the experiment, the progress of the student experiment won't suspend if somebody inserts or plugs the experimental box during the experiment.

Summary and Outlook
Comparing with traditional embedded experimental teaching methods, the remote sharing
platform based on embedded experiment put forward in this paper has advantages of high utilization of the equipment, little restriction on the time and the space, distinct convenience in teaching management. The platform is a try to match the need of experimental teaching and remote teaching for educational reform.

Successful practice on the teaching pilot indicates that the system can arouse the students’ enthusiasm obviously and encourage them to put more effort on study. At the same time, the sharing mechanism eases the problem of resources shortage in the laboratory, while the automatic appraisal mechanism relieves pressure of teachers.[4] To sum up, the platform has obtained good result in the pilot project, indicating that the platform can be used as an effective auxiliary in the embedded experiment teaching. What's more, the guidance concept and design ideas of the platform, as well as the practical experience in pilot teaching, can arouse new ideas for other experimental teaching reform.

Acknowledgements

The authors want to thank Tong Zhang, Yue Jin, Yingcai He and Jibin Xu for their pertinent suggestions for our research and helping us to apply the platform to teaching practice. The research was sponsored by University Students’ Innovative Research Funding of Beijing University of Posts and Telecommunications and Education Reform and Research Project in 2014 of Beijing University of Posts and Telecommunications.

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