[Practical Paper] Trial of a distance learning system using a brain wave sensor

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Abstract—We developed a self-study system using Perl language. To date, no device has been available to observe a human state effectively. However, brain wave sensors have become inexpensive recently, allowing observation of the human state. We analyzed the information effectively; a brain wave sensor for human feedback has become usable. This feedback system can measure a student's state of concentration and a state of a motivation. Additionally, students show raised motivation because the system transmits a message indicating motivation. Sensing that motivation, effective methods can be recognized. This report presents our results.

Keywords: Brain wave sensor, Perl language, Distance Learning, e-Learning, Blended Learning, e-Collaboration

1 INTRODUCTION

In recent years, growing interest has arisen in the progress of information and communication systems, high-speed networking, and multimedia environments [1]. Software development has become large-scale and complicated. Consequently, independent systems have become increasingly rare. Student skills related to system design and communication are therefore not good. We must consider learning systems that exploit group communication and iteration of practice to develop good quality software [2].

During cooperative software development, the same information must be taught repeatedly for it to become practical knowledge [2][3]. We produced a distance education system that can instruct students repetitively, but it is difficult to complete a program using this distance learning system alone.

To date, it has been extremely difficult to respond while grasping the state of a student using a distance learning system [4]. Nevertheless, we can cheaply use a brain wave sensor to observe the state of a student. We experimented on construction of a system for learning while using this feedback [5][6].

2 PROBLEMS AND PRESENT CONDITIONS

From the beginning, remote education systems have presented the problem of whether or not the learner is well accustomed to accessing the necessary media electronically. The learner is isolated: aside from the learning system itself, they can contact only an instructor. Therefore, the learner is usually apprehensive, wondering whether the system will behave as expected, whether the system is useful as expected, and whether it is possible to access the necessary contents associated with the received lectures.

It is very useful to measure the feeling of a student and their level of consciousness using distance learning systems. Such a system can feedback information from the students.

3 SYSTEM OVERVIEW

This system consists of basic software ideas for general learning based on the Perl language, including specifications for the specific learning method. In addition, the system includes an information bulletin board and chat room. It is possible to exchange messages with other learning members. The system shows the students' grade situation by ranking their relative progress.

This system is supported by both Linux and Windows operating systems. A student accesses the web browser via a personal computer. Students start advanced learning and group work using learning support and communication support. Then they start personal learning and group work with learning support and communication support. They can check their degree understanding by solving some problems for confirmation. A learner and lecturer can communicate. They can examine a function of a language using a database. An image of this system is presented in Fig. 1.
In addition, the system can measure the state of learners such as concentration power using the brain wave sensor.

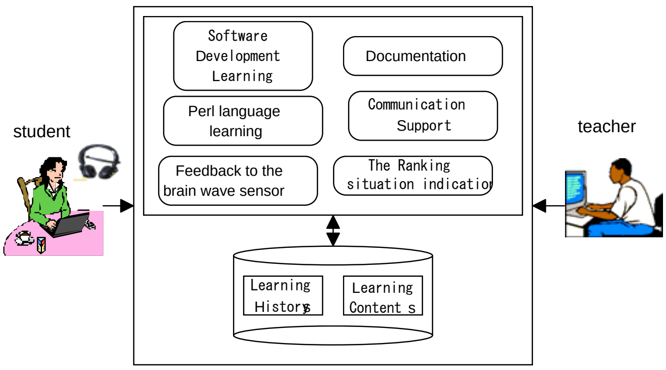

Figure 1: System image.

4 CONTENTS OF LEARNING

4.1 Learning Software Development

When students learn software development, they learn the contents on the Web. These contents for learning are generated using Power Point (Microsoft Corp.), but are then converted into HTML format. The contents are separated into five levels of learning for software development. Confirmation questions are prepared at each level. Moreover, if all chapters are completed, then students must answer a series of 20 questions.

・Support contents

Software development, requirement analysis, software design, program testing and maintenance

4.2 Documentation

When students are working on problems using the program, the system checks their understanding of the situation. The learning contents generated using PowerPoint are changed to HTML. The specification's documents are classifiable into three categories:

(1) External specifications form
(2) Internal specifications
(3) Test specifications

After each level is completed, a validation test is performed, followed by validation planning. Through a selection process, we correct the students' understanding. The documentation content is shown in Fig. 2.

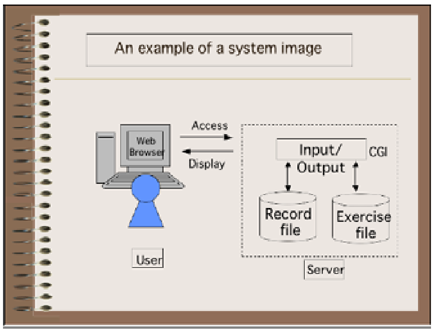

Figure 2: Documentation.

4.3 Using Perl Language

(1) Usage of Perl language

The programs are classified according to the item and display a step-by-step process on how to use Perl language functions. Each function is then displayed entirely making it easier to examine the parameter. The main functions are printf, scanf, if-else, array, for and while.

(2) Exercise to understand the Perl program

The purpose of this exercise is to confirm what content was understood by the student from using the given Perl explanations. The exercise is selective and provides a percentage representing the degree of comprehension.

(3) Perl Program Exercise

This displays both the Perl program's mock validation exercise and the implementation section. Step 1 consists of validation, and it displays the content (e.g., the parameters and results of the program). After the students input their functions into the text field, they can confirm the entry by running the program.

When students do not comprehend the basic function, an example answer is displayed. They can confirm it through this step. This creates a simple explanation that is sufficiently clear for a novice programmer to comprehend. Step 2 consists of implementation in an exercise form. They can experience a mock implementation and debugging of a complicated program. These ideas are displayed in Fig. 3.

・Discussion Board Q&A

This section is used for questions and for information exchange between the teacher and students. This section also allows the teacher to create or respond to messages. The page's background color changes whenever a new message is posted alerting students of the message.

・Message Exchange

This section carries sent questions and other information exchanges on a peer-to-peer level. Even with encrypted mail addresses, messages can be sent using a user-defined nickname.

(1) Mail transmission function and data exchange
(2) Mail receiver function
(3) Mail transmission and history function
(4) Learning schedule setting and communication function

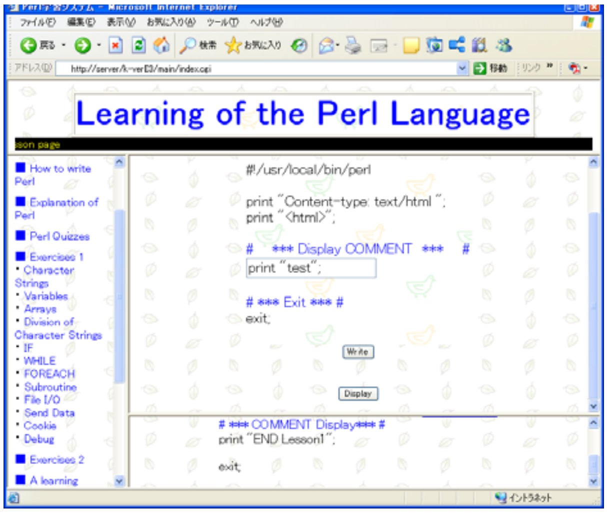

Figure 3: Programming image.

4.4 Support for the module

This support function programming technique lets learners practice basic program-linking to enable the learner to experience test trials to learn how to link modules.

Listed below are the practice steps to be followed.

· Practice of maintaining data integrity
· Practice of correcting programs for linking
· Practice of multi-program linking as a test trial

Following are additional descriptions for practice.

(1) Practice of maintaining data integrity

This is provided to the learner to show points of caution when exchanging data among modules. Every learner is expected to join a group for this purpose; everyone in the group is expected to enter variable names or real numbers that come to mind. Through this process, among other things, the learner is expected to learn how important it is to use consistent variable names in a specification document.

(2) Practice of a correcting programs for linking

The learner practices programming for module linking by giving the learner a program for use to link some modules in which at least one error is included intentionally. Consequently, the learner must correct the erroneous portion to finish the module linking. In this practice lesson, a mode of giving special attention was provided, by which the color of the program line number changed when the learner corrected the wrong line mistakenly, or when the learner put wrong information related to a line, even though the line number itself was correct.

(3) Practice of multi-program linking as a test trial

The learner is provided with a program in which some program statement portions are intentionally left missing. The learner is then expected to complete the program to make it work properly while simultaneously reviewing and checking the associated specification. The program has been left intentionally as missing an important segment to exchange data when linking modules. Then the learner is expected to complete such an incomplete program, thereby learning the importance of data structures that are used when modules are linked.

4.5 Ranking Identification

A teacher can follow the learning progress of a student using the Web application. Students can track their progress status using a clear bar graph. The system delivers each Q&A using a mailing list and searches the mailing list's archives. From the instructor's side, it is possible to see the progress of students. This allows the instructor to measure the gap separating students. It is also possible to add explanations or hints for specific lessons, such as helpful teaching materials to assist the students' learning and progress further.

Students can also receive an explanation of the lecture via PowerPoint (Microsoft Corp.). When students wish to see a lecture's contents, they can observe the contents on their personal computer using the HTML conversion.

Each student can browse practicum contents using a personal computer. The content advances according to the student's own progress. The practicum content is created from JavaScript and is displayed as PowerPoint (Microsoft Corp.) changed to be displayed as HTML data. After the students solve the practicum problem by attending lectures, the answer is submitted on paper. Students can see their relative ranking in the class at any time. The teacher can easily supervise each student's progress, thereby allowing a direct channel to advise those who have fallen behind.

If a question or comment is brought up during a lecture, that question could be posted in the discussion board's Q&A section for all students to access easily. The background color of the page would be changed when a new message is submitted allowing for rapid notification to students. Students have access to contact the teacher and other students via e-mail.

Students can learn in their spare time while attending school for lectures and can then pose face-to-face questions. The program allows students to learn from the privacy of their home using a mobile phone or personal computer. The program allows each student to plan their own schedule. If a student falls behind schedule, then a reminder message is sent to their mobile phone. The problems presented to students in the study support section of this system are presented in a multiple-choice format. These are prepared before lectures. Students can exchange information with the teacher and other students using the communication function.

The teacher can observe any particular problem that students are working on at any time throughout the process. This function displays each student's progress in relation to the whole group. In addition, students can see the rankings of other students who are solving the same problems. The practicum's progress is displayed for students as shown in Fig. 4.

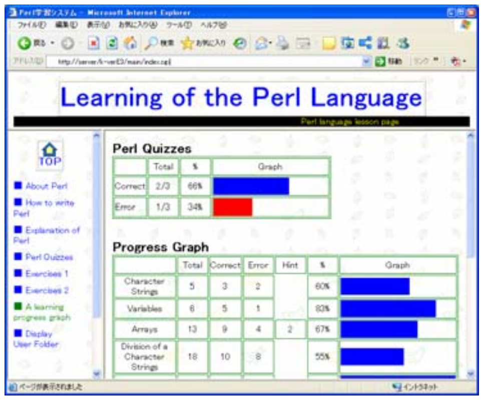

Figure 4: Bar graph showing progress.

The teacher can supervise the class by observing the list of problems that each student is currently solving. This allows the teacher to advise any student who has fallen behind, as well as students whose progress has stopped altogether. This function also permits the teacher to track the overall progress and understanding of the class' content better.

5 RESULTS AND EVALUATION

5.1 PERIOD AND METHOD

We used a seminar method and a distance learning system for third-year students of our department [6]. The period was four months. The contents that we used were shared with three groups and used as described below. We divided 10 students into three groups with 4, 4, and 3 members.

First, the installation of Apache and the Perl language are expected to be done on the local server. Thereby, the learner is expected to understand how and in what combination the Perl language would work with the Apache server as a system overall. Such a work of understanding would include a problem for which knowledge that the learner has acquired is insufficient. In other words, support from the instructor is necessary: otherwise, the problem might be difficult to resolve unless a quick response to the questions the learner might have is given through a blended learning technique.

Subsequently, premised on the understanding of c language, students learn about the relation between html and CGI. Students learn themselves through self-study about a Perl language function that is supported by Perl language. For the ensuing month, students learn the basics of Perl language to file access. Then they understand the entire Perl language. They learn basic information related to connections among programs using a program combination support function [7].

Students started group work in the third month. First, they chose a leader among the members. Next, they discussed problems among groups and decided the subject of the program they wanted to make. In these circumstances, they learned using this support system, along with communication through mail and chat facilities. Seminars were held twice a week.

5.2 Contents and Results

After they decided which program to make in their groups, they chose a title and performed basic specifications design. They decided the charge part of a program among members after having determined an external design and a user interface. Students designed the data structures of programs of the charge program. Each member wrote the documentation. After each program that they debugged was completed, they combined the programs and reached completion.

They chose “(1) A bulletin board that recorded an access history and blackjack; (2) An electronic shopping lacing braid purchasing system [The example images display by Fig. 5]; (3) A Web page that combined touch-typing with a game.”

Use of the brain wave sensor revealed that all groups confronted difficulties related to file input and output by CGI and a combination of programs. Programs were finished through group work. They were improved through a combination of a program to arriving at high technology through a generation process. Standardization and documentation were improved at a certain level using this practice as well.

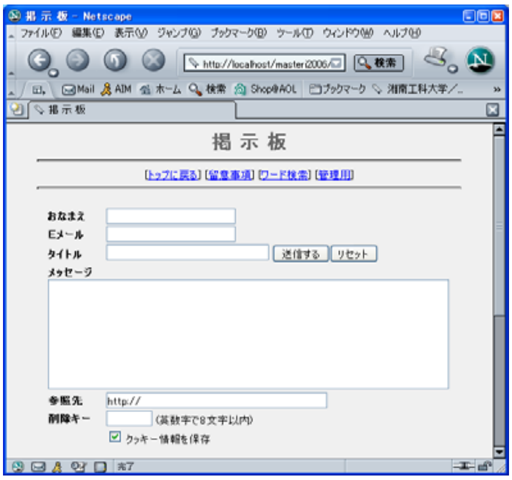

Figure 5: Screenshot of an e-Shopping Mall purchasing system.

5.3 Results and Evaluations

Evaluations of the self-study supporting functions of Perl differed depending on the level of programming used by the student. Regarding support for combining the programming, although comprehension grew by presentation of examples showing the difficulty of combining programs and problem occurrence while remaining conscious of documentation and standardization, it remained at the knowledge level.

In the meantime, with electronic communication, although information and knowledge are conveyed somewhat, detailed explanation of complicated contents is difficult. Therefore, a means for explaining concrete images and complicated matters briefly using motion pictures and illustrations in addition to letters is necessary. Furthermore, what one has to say can only slightly involve emotional content. In particular, students are not accustomed to electronic communications. They are not good at using mailing lists and chatting.

Under these circumstances, the brain wave sensor was used; the obtained results were fed back. Then we obtained the following findings:

(1) Reading the explanation of Perl language

There is a premise understanding Perl language by a seminar to some extent. Therefore an examinee is relaxed at the time of a start. Content is not so difficult. An examinee loses an intensive degree to understand contents, and meditation degree rises adversely. When an examinee passes around 4 minutes, an intensive degree rises and follows afterwards while concentration goes up and down (Fig.6).

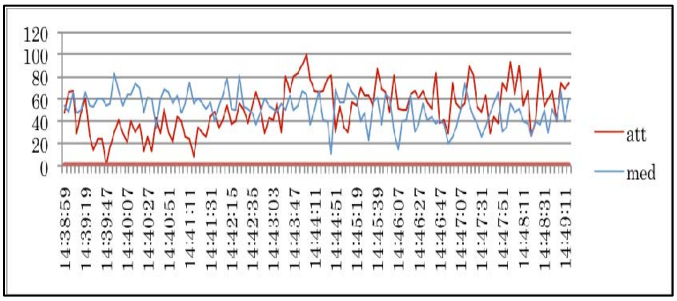

Figure 6: Example of reading the explanation of Perl language.

(2) Solving a question of Perl language

When the examinee began easily about the question, for example Print sentences or so. He answered the question with highly meditation degree. And a variable and an arrangement are simple, but concentration (att) rises so that a thought is necessary in various ways when he become a condition sentence. Concentration declines when he stands around 10 minutes (Fig.7).

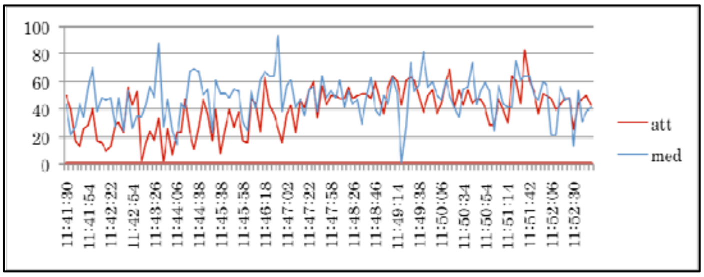

Figure 7: Example of solving a question of Perl language.

5.4 Evaluations and Discussion

Use of the brain wave sensor enables objective measurement of motivation and concentration power of the learner. In general, this enables detection of items that learners have difficulty understanding and those which cause stress. It is also possible to know favorite and weak subjects of individual learners, motivation depending on feelings that day, and the degree of concentration power.

Therefore, it is considered that construction of a finely designed follow-up system is possible using a distance learning system into which this brain wave sensor is built.

6 CONCLUSIONS

To date, blended learning has been incorporated into the distance learning system and effects of group learning were used. Under these circumstances, the brain wave sensor was used in this study, enabling effective measurement of the state in which the learners are learning.

As expected, results reveal that learners are in stressful circumstances in preparing specifications that are difficult to understand and in preparing combinations of programs that necessitate communication. In contrast, repeated learning and language learning such as Perl language, in which examples are presented clearly, support stress-free learning.

In the future, the authors intend to analyze functions of the distance learning system that ensure better effects and to analyze features of contents through detailed assessment of these findings and verification of their applications. This study received support from the scientific research cost subsidy “22500949” and from the organizations named above.

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