Inf Syst Front (2006) 8:297–306
DOI 10.1007/s10796-006-9004-5

A web-based e-learning system for increasing study efficiency by stimulating learner's motivation

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Published online: 14 November 2006

Abstract Due to the opportunities provided by the Internet, more and more people are taking advantage of distance learning courses and during the last few years enormous research efforts have been dedicated to the development of distance learning systems. So far, many e-learning systems are proposed and used practically. However, in these systems the e-learning completion rate is about 30%. One of the reasons is the low study desire when the learner studies the learning materials. In this research, we propose an interactive Web-based e-learning system. The purpose of our system is to increase the e-learning completion rate by stimulating learner's motivation. The proposed system has three subsystems: the learning subsystem, learner support subsystem, and teacher support subsystem. The learning subsystem improves the learner's study desire. The learner support subsystem supports the learner during the study, and the teacher support subsystem supports the teacher to get the learner's study state. To evaluate the proposed system, we developed several experiments and surveys. By using new features such as: display of learner's study history, change of interface color, encourage function, ranking function, self-determination of the study materials, and grouping of learners, the proposed system can increase the learning efficiency.

Keywords Web-based systems · E-learning · Increase of learning efficiency · Stimulating learner's motivation · Grouping of learners

This work is supported partially from the following institutions. (1) Computer Science Laboratory (CSL), Fukuoka Institute of Technology (FIT), Japan, Project Nr. H-48. (2) Japan Society for the Promotion of Science (JSPS), Grant-in-Aid for Scientific Research (C) (2), Project Nr. 16500043.

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1 Introduction

Due to the opportunities provided by the Internet, more and more people are taking advantage of distance learning courses. During the last few years enormous research efforts have been dedicated to the development of distance learning systems (Nakabayashi et al., 1999; Katayama & Kambayashi, 1999; Ohkawa et al., 2000; Sato et al., 1999). Consequently, many large projects such as CALAT; CALsurf; WebCAI; The University of the Air; California Virtual University; WIDE University; Ogawa et al., (1999); and DAI-X Web College have been establised. However, in these systems the e-learning completion rate is about 30%. One of the reasons is the low study desire when the learner studies learning materials. Therefore, it is very important to stimulate learner's motivation during the study.

Recently, several distance learning systems that consider the learner's capability and understanding have been proposed (Matsumoto et al., 1999; Tamaki et al., 2000;

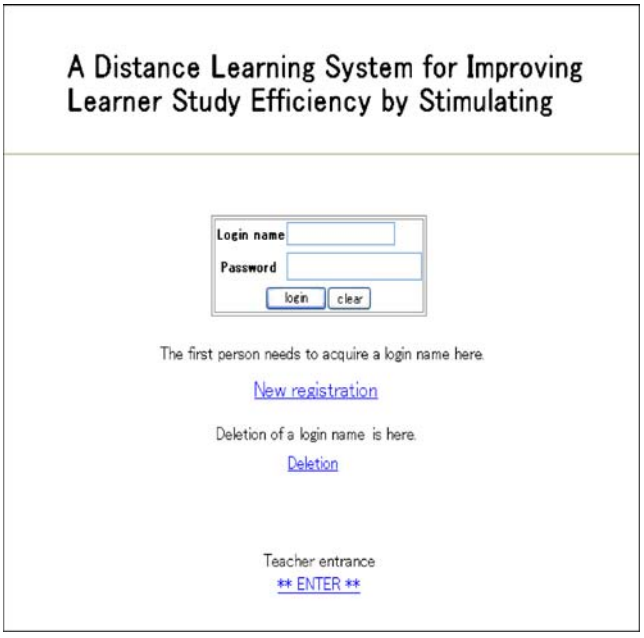


Fig. 1 Proposed system interface

Kuwabara et al., 2000). In Matsumoto et al. (1999), an evaluation system of historical data, based on learning environment and supported by educational software record is proposed. In this system, reappearance and analysis are carried out only for historical learning data and not for real education system with individual student advancement control (MESIA). The system is able to keep the teacher operating cost low and to offer fine education by the cooperation of Computer Assisted Instruction (CAI) and teacher. The system is able to recognize the learners who need assistance, but its main purpose is to support the teacher, not the learners.

In our previous works (Koyama et al., 2001, 2002; Barolli & Koyama, 2004, 2005), we proposed an agent based distance learning system to deliver appropriate studying materials to learners and stimulate learner's motivation by using mental action of color (Tatsuno, 1995; JCRI, 1993).

In order to offer a suitable and efficient study for learners, in this work, we propose a Web-based distance learning system in order to increase learner's efficiency. The proposed system has three subsystems: learning subsystem, learner supporting subsystem and teacher supporting subsystem. The purpose of our system is to increase the e-learning completion rate by stimulating learner' motivation. To evaluate the proposed system, we developed several experiments and surveys. The evaluation shows that by using new features such as: display of learner's study history, change of interface color, encourage function, ranking function, self-determination of the study materials, and grouping of learners, the proposed system can increase the learning efficiency.

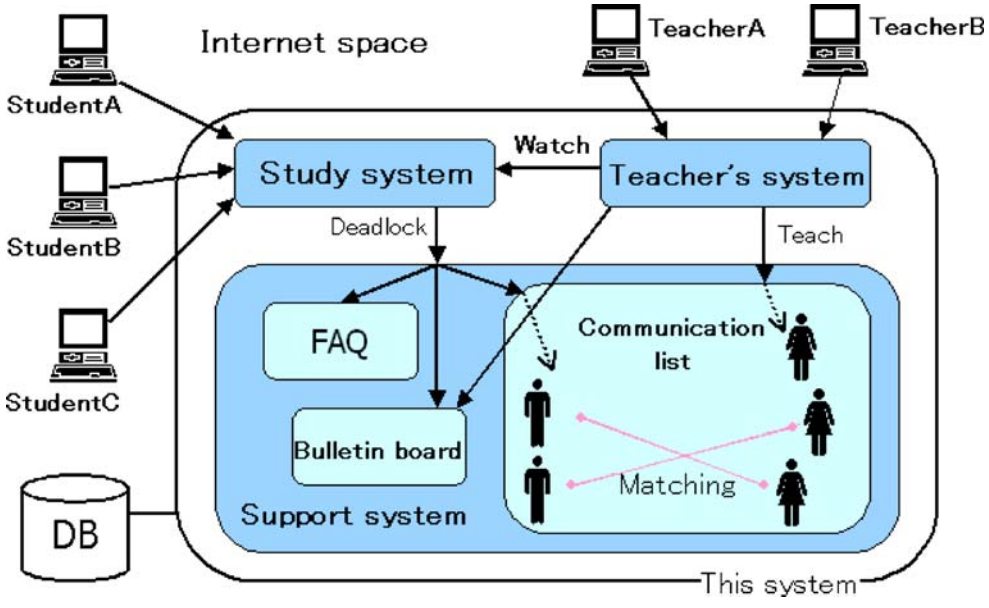
The paper is organized as follows. The system structure is introduced in the next section. In Section 3, we present the evaluation method for the proposed system. In Section 4, we discuss the evaluation results. In Section 5, we compare the functions of the proposed system with MESIA. Finally, we give some conclusions and future work in Section 6.

2 Proposed system structure

The proposed system is built on World Wide Web (WWW). In order to have a wide range of applications, we use only standard functions. Therefore, the system can be easily used without depending on the computer environment.

The proposed system interface is shown in Fig. 1 and the system structure is shown in Fig. 2. The page output is

Fig. 2 System structure



generated by using JSP. For the system logic, we use Java and Java Servlet and as relational database system is used PostgreSQL. Java Programming is used as the study material. The proposed system has three subsystems: learning subsystem, learner supporting subsystem and teacher supporting subsystem.

The learning subsystem includes the studying materials, examination exercises, and some functions to stimulate learner's motivation. The learner supporting subsystem supports the learners when they have problems during the study (in this subsystem are implemented some interaction functions). The teacher supporting subsystem has some functions to get the study situation of learners and to give hints from the teacher to improve the learning efficiency.

The proposed system works in the following way. At the beginning, the learner starts to study the learning materials. The teacher checks the learning situation and based on that decides how to support the learner. In the learner support subsystem is implemented the Windows Messenger (WM). Using the messenger, the teacher and learner can communicate together. If the learner understands the problem he asked the teacher, he goes back to the learning subsystem and starts again learning process.

2.1 Learning subsystem

The interface of e-learning system is shown in Fig. 3 and the e-learning flow is shown in Fig. 4. At the beginning, the learner logins to the system. Next, if the learner understands the text, he starts to do the exercises. Then, the obtained results and ranking are shown in the computer display. After that, the learner decides the next items to study. If the learner does not understand some parts of the text, the learner moves to the learner support subsystem, when understands all the text goes back to the learning subsystem.

2.2 Teacher supporting subsystem

In this subsystem, the person who is registered as teacher can enter the system by using the registered login and password. By using this subsystem, the teacher is able to judge the learning situation of the learners. The teacher can check the following items.

- The learners who are using the system.
- The items which are finished.
- The learner has problems during the study or not (is the learner using the learner supporting system or not).
- The FAQ of the learner support subsystem.
- The Bulletin Board (BB) of the learner support subsystem.

If the teacher finds that a student is using the learner support subsystem, by using e-mail, the teacher can communicate with the learner. It is also possible to communicate with the learner by using WM.

The main interface of the teacher supporting subsystem is shown in Fig. 5. This page is divided in two frames. The left frame shows the learners who are logged in the system. They are shown in a table form. The table shows the following information.

- The learners are on line or not.
- The present study item.

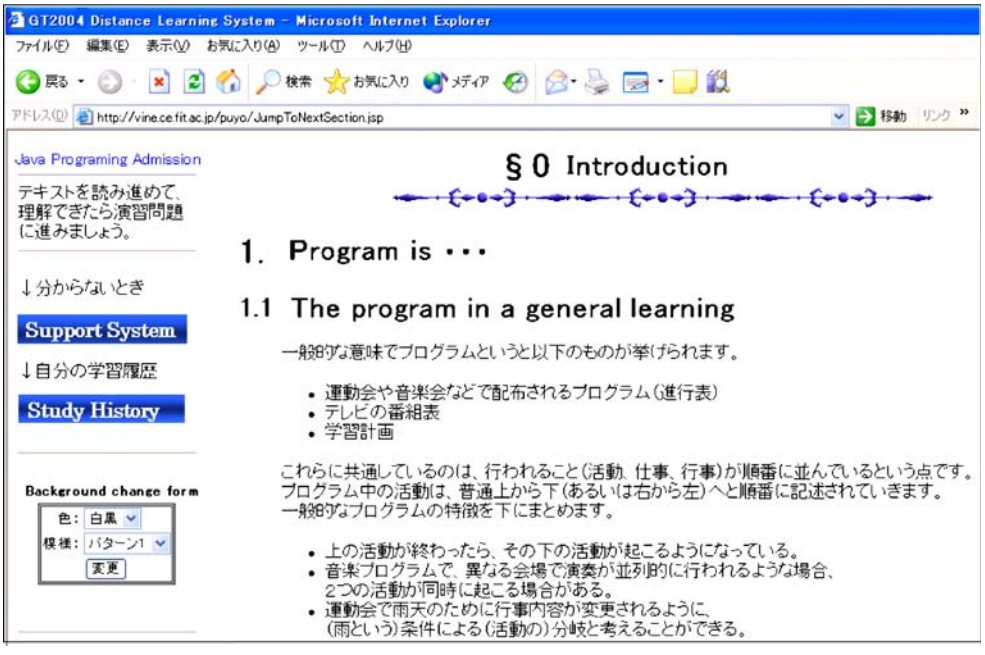


Fig. 3 Interface of e-learning subsystem

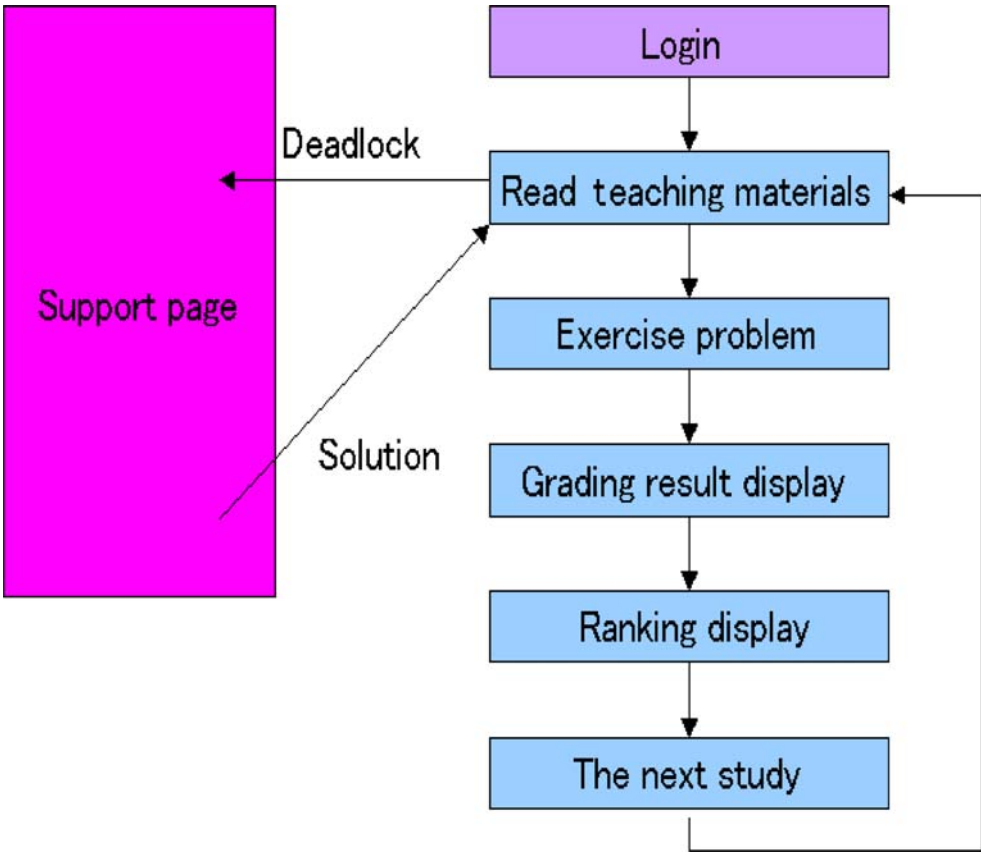


Fig. 4 E-learning flow

- The learners who are using or not the learner support subsystem.

It should be noted that the table is changed in a real time if a learner enters or leaves the system. Also, when the login name of a learner inside the table is clicked, the detailed information of the learner is displayed in the mainframe. This information includes:

- Login name,

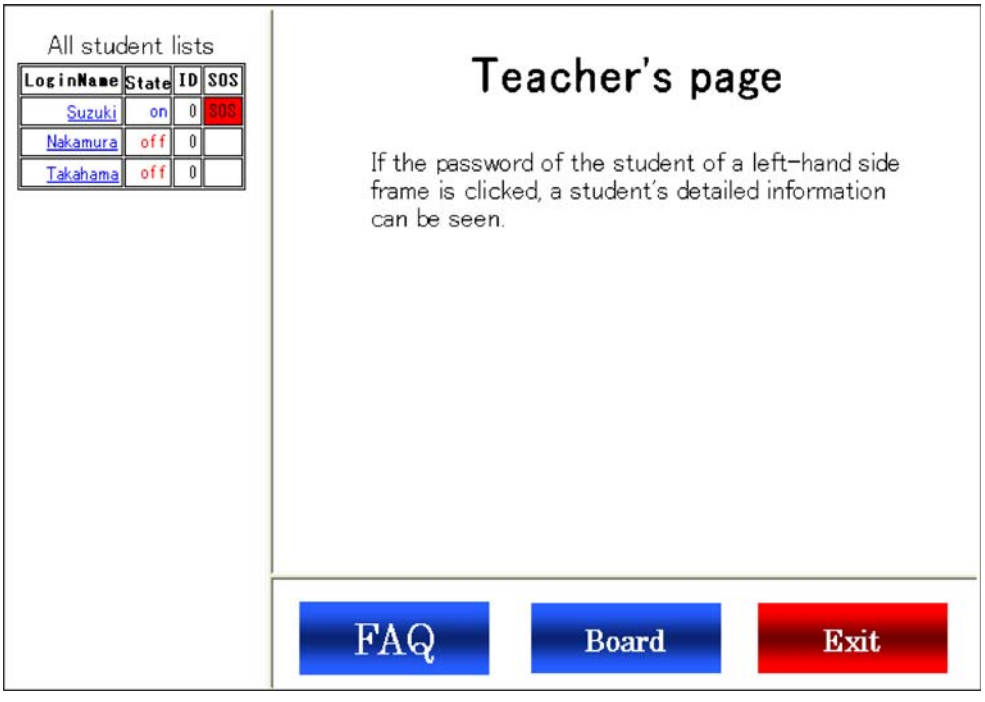


Fig. 5 Teacher interface

- The learner name in Japanese (Furigana),
- Learner e-mail address,
- Learner present learning state,
- The study history.

If a learner has problems during the study, the teacher can use the e-mail and WM to communicate with the learner. By using WM, it is possible to have voice chat or video chat. Also, because the FAQ and learner support subsystem are linked in this page, they can be referred if they are needed. The BB can be used by teacher to explain the content that the learners do not understand.

2.3 Learner supporting subsystem

The learner supporting subsystem is used to help the learners when they have problems during the study. This subsystem includes:

- FAQ,
- BB,
- The list of persons who can communicate together.

The learner can investigate by FAQ whether there are answers of previous questions related with the content that the learner is studying or not. If there are not answers about the previous questions, the learner waits until the answer will be shown in the BB. If the learner needs the answer in a real time he enters in the Member List. Then, the present learner can select a member who answered the questions in the previous test and communicate with him using WM. In Fig. 6 is shown the main page of the learner support subsystem.

2.4 Interactive functions

The proposed system has the following communication modes.

- Communication between students.
- Communication between the student and teacher (question mode).
- Communication between the teacher and student (explanation).

All these communications are done in the synchronous mode. However, by using the e-mail the system can offer also asynchronous mode communication. Thus, the proposed system different from other implemented e-learning systems can support the learners and teachers to communicate with each other in synchronous and asynchronous modes.

3 Proposed system evaluation method

In order to evaluate the proposed system, we used some questionnaires and asked the learners how the system performed and especially how the system stimulated the learner's motivation. For the experiment, ten students and two professors of our laboratory used the system and then we prepared three questionnaires as shown in Tables 1, 2 and 3.

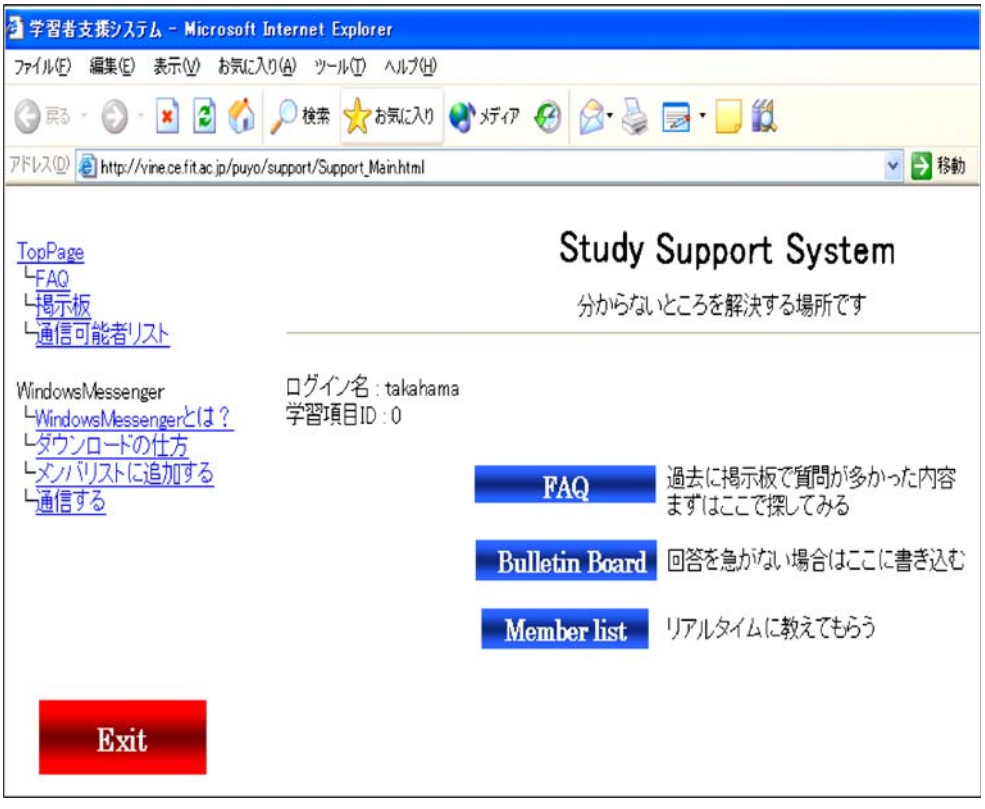


Fig. 6 Learner support subsystem

Table 1 First questionnaire

First questionnaire: How much the following functions improved the learner's motivation?	
Question number	Question contents
Q1	Display of the learner study history
Q2	Change of the interface color
Q3	Function that encourage learner study
Q4	Ranking display
Q5	Self-determination of the study materials

The first questionnaire has questions related with improvement of learner's motivation. The second questionnaire has questions about the interactive functions. Finally, in the third questionnaire are written the comments and suggestions from the teachers and students. We used a five grade evaluation system. When the grade is higher, it shows that the system provides better functions. Finally, in the last experiment, we used 15 learners to check how the system does their grouping.

4 System evaluation results

The evaluation results for the proposed system are shown in Figs. 7, 8 and 9. In Figs. 7 and 8 are shown the average values received from the questionnaires. As can be seen from these figures, the proposed system was evaluated with good scores for both the learner's motivation and interactive functions. Also, if we see the results of Fig. 9, the overall system evaluation values are more than average value. This shows that the proposed system has a good performance.

However, the proposed system needs still improvements. For example, encourage function was a text based function and did not provide a good stimulation. Also, the communication between the students and teacher (when they ask questions to the teacher) compared with other communications modes had a lower evaluation. Therefore, this communication mode should be improved.

Considering, the comments and suggestions in Table 3, one of the teachers said that it will be better if the teacher and students match each other. Sometimes, there are some students that are not adapted with the way of teaching of some teachers. For this reason, it will be better if the system has some functions to deal with this problem. Also, the learner "A" said that he did not feel good that other learners know his ranking position. So, the privacy is another problem that should be considered. Another learner "F" said that he was concerned with the system security, because may be the information may flow and be seen from a third party. Therefore, we should consider also the security problems. The learner "J" suggestion was that will be better if there is a function that compares the results of a learner with his friends. So, the learners do not like to show their ranking to all learners in the system. But, it is not a problem if it shown to their friends. The learner "A" also suggested that the communication between students had a good effect on the learning efficiency. It looks that our system provided a good function in the case that the learner's

Table 2 Second questionnaire

Second questionnaire: How much the interactive functions improved the learner efficiency?	
Question number	Question contents
Q1	Communication between students
Q2	Questions from a student to a teacher
Q3	Explanation from a teacher to a student
Q4	Communication functions (Chat, BB, e-mail)

Table 3 Third questionnaire

Third questionnaire: Comments and suggestions	
Teacher/Learner	Comments and suggestions
T2	It will be better if the teacher and learner match each other.
A	• It is not good that other learners know my ranking position. • Teacher explanation was unclear. • Communication between students had a good effect on the learning efficiency.
C	Encourage function is just a text message.
F	It should be problem if the system is not secure.
J	It will be better if there is a function that compares the results of a learner with his friends.

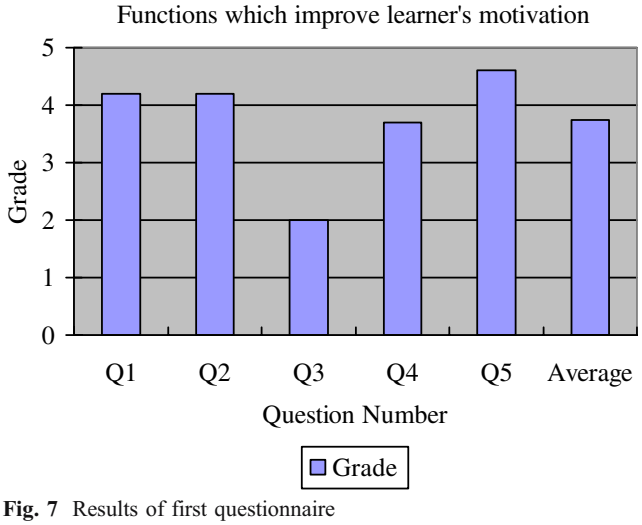


Fig. 7 Results of first questionnaire

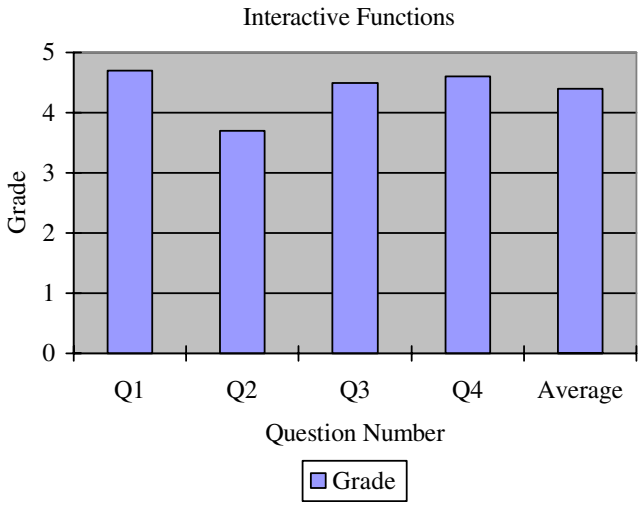


Fig. 8 Results of second questionnaire

question was not in the database. In this case, the learner can communicate with other learners present in the system and ask about the problems that did not understand. By providing these kinds of functions the learning efficiency can be increased.

To deal with abovementioned problems, we will improve the proposed system as follows.

- Improving the encouraging function by using not only text but also the animations.
- Providing a matching function between learners and teachers.
- Providing a ranking function for teachers to improve their teaching efficiency.

In the last experiment, 15 learners used the system and we collected the following data: Test Result (TR), Reference Time (RT) of studying materials, and Number of Reference (NR) of each item. The Average Value (AV) and Standard Deviation (SD) for each parameter are calculated by using formulas 1, 2, 3, 4, 5, and 6, respectively. The deviation values of TR (TRD) are decided based on formula 7, the deviation values of RT (RTD) are decided by formula 8, the deviation values of NR (NRD) are calculated using formula 9, and the Reference Efficiency (RE) values are calculated by formula 10. In these formulas, *xi*, *yi*, and *zi* are the data for each user in TR, RT, and NR columns of Table 4.

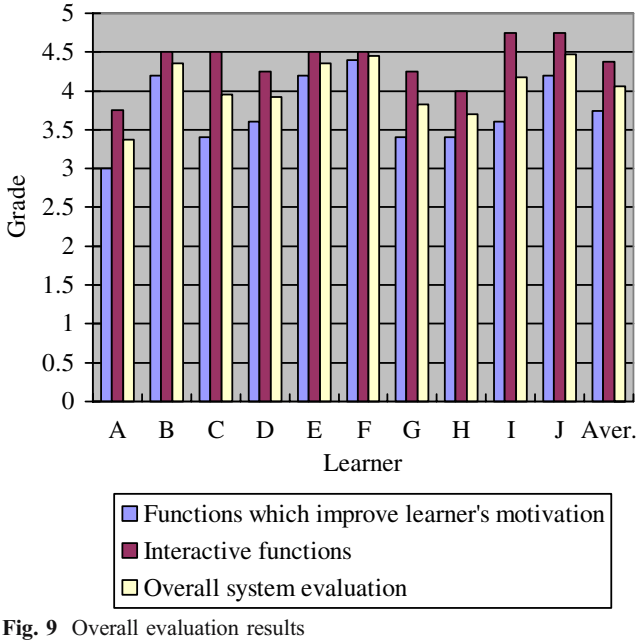


Fig. 9 Overall evaluation results

$$AV_{TR} = \frac{1}{N}\sum_{i=1}^{N} x_i \tag{1}$$

$$AV_{RT} = \frac{1}{N}\sum_{i=1}^{N} y_i \tag{2}$$

$$AV_{NR} = \frac{1}{N}\sum_{i=1}^{N} z_i \tag{3}$$

$$SD_{TR} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} x_i^2 - AV_{TR}^2} \tag{4}$$

$$SD_{RT} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} y_i^2 - AV_{RT}^2} \tag{5}$$

$$SD_{RN} = \sqrt{\frac{1}{N}\sum_{i=1}^{N} z_i^2 - AV_{NR}^2} \tag{6}$$

$$TRD_i = \frac{x_i - AV_{TR}}{SD_{TR}} \times 10 \tag{7}$$

$$RTD_i = \frac{AV_{RT} - y_i}{SD_{TR}} \times 10 \tag{8}$$

$$NTD_i = \frac{AV_{NR} - z_i}{SD_{NR}} \times 10 \tag{9}$$

$$RE_i = \frac{RTD_i + NRD_i}{2} \tag{10}$$

The learners grouping is carried out based on TRD and RE. In order to verify the experimental results, after the experiment, we carried out and investigation for each learner using a questionnaire and compared the experimen-

Table 4 Experiment results

Learner	TR [%]	TRD	RT [s]	RTD	NR	NRD	RE
A	65	−20.1	285	6.9	25	4.9	5.9
B	70	−15.1	364	4.4	24	6.9	5.7
C	85	4.7	542	−1.5	24	6.9	5.4
D	70	−10.2	160	10.9	24	6.9	8.9
E	75	−5.2	321	5.7	24	6.9	6.3
F	75	−5.2	680	6.0	44	−32.7	−19.4
G	90	9.6	700	−6.7	27	0.9	−2.9
H	75	−5.2	223	8.9	24	6.9	7.9
I	70	−10.2	636	−4.4	29	−3.1	−3.8
J	100	19.5	373	4.1	25	4.9	4.5
K	95	14.6	698	−6.3	28	−1.1	−3.7
L	90	9.6	672	−5.7	27	0.9	−2.4
M	80	−0.3	922	−13.8	31	−7.0	−10.4
N	100	19.5	862	−11.9	25	4.9	−3.5
O	75	−5.2	658	−5.0	31	−7.0	−6.0

tal results with questionnaire results. The experiment results are shown in Table 4 and the grouping of learners is shown in Fig. 10.

- The group I has a good RE value, but TRD is not so good. The learners in this group have a low degree of understanding. According to the questionnaire investigation after the experiment, it was proved that degree of understanding was low, because there were many careless mistakes. Therefore, the system should inform these learners to be more careful during the study.
- The group II has good RE and TRD. The learners belonging to this group have high degree of understanding. In the questionnaire, C and J said that content of studying materials was very easy. Therefore, the system should give more difficult exercises in following learning steps.
- The group III has bad RE and TRD. According to questionnaire investigation, the learners in this group wanted more easy materials. Therefore, it is necessary to give more illustrated examples such as animations or images in order to get a better understanding.
- The group IV has a good TRD, but a bad RE. The learners of this group have study desire, but not good study efficiency. From the questionnaire investigation, we found that three persons among four learners checked very carefully studying materials. Therefore, the system should inform the learners to make more questions about the items they did not understand. Thus, they can increase the study efficiency.

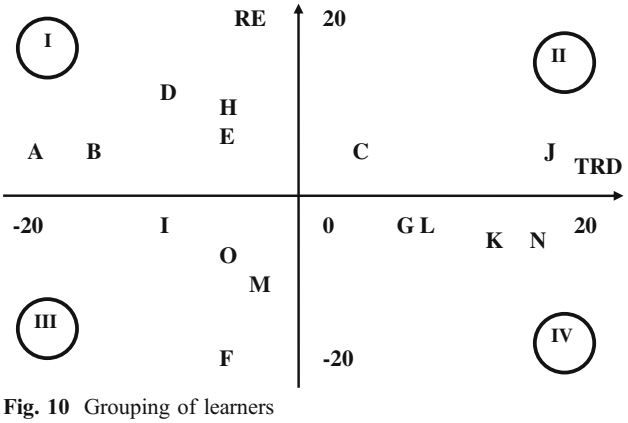


Fig. 10 Grouping of learners

5 Comparison of MESIA and proposed system functions

The comparison between MESIA's and the proposed system's functions is shown in Table 5. In the proposed system the BB is used to give the hints by teacher, but in MESIA the hints are used to advice the learners on wrong answers and HELP/MORE for guiding learners to correct answers. As test function, MESIA uses a short test, while in our system the learner repeats the exercises until he passes the test. For teacher–student interaction, in MESIA are used

Table 5 Comparison of MESIA and proposed system functions

Functions	MESIA	Proposed system
Hint	O HELP/MORE, Hint	O Hint
Test	O Subtest	O Repeat exercises
Teacher and student inter-action	O Message	O E-mail
Questions from students	O Teacher answer	O Teacher answer
Network environment	O Intranet	O Internet
Synchronous learning	O	O
Asynchronous learning	X	O
Learner's motivation	X	O

the messages while in the proposed system is used the e-mail. In the case when a learner wants to ask the teacher a question, in MESIA is used an online message or video meeting, while, in our system, the teacher answers the student's question by e-mail. Also, in our system the teacher and students can communicate in real time using WM. The MESIA is used in the Intranet environment, while the proposed system is a Web-based application and can be used in Internet environment. In order to have an efficient study, in MESIA the student and the teacher should have a synchronous interaction. The proposed system can be used for synchronous and asynchronous learning. MESIA does not have a function to stimulate the learner's motivation, while in the proposed system, the display of learner's study history, change of interface color, encourage function, ranking function, self-determination of the study materials are used to stimulate learner's motivation.

6 Conclusions and future work

In this paper, we proposed a Web-based distance learning system in order to increase learner's efficiency by stimulating learner's motivation and providing some interactive functions.

The proposed system has three subsystems: learning subsystem, learner supporting subsystem and teacher supporting subsystem.

We verified the system performance by using some questionnaires and experiments. The proposed system was evaluated with good scores for both learner's motivation and interactive functions. The overall system evaluation values are more than average value. This shows that proposed system has a good performance. Also, the evaluation results show that by making the grouping of learners the system can decide what kind of materials should be given to each learner.

However, the proposed system needs still improvements. For example, encourage function was a text based function and did not provide a good stimulation. Also, the communication between the students and teacher should be improved. Improvement of teaching materials is also necessary to stimulate learner's motivation.

In the future work, we want to deal with the following problems.

- Learner's privacy.
- System security.
- Improving the encouraging function by using not only text but also the animations.
- Providing a matching function between learners and teachers.
- Providing a ranking function for teachers to improve their teaching efficiency.

Acknowledgements The authors would like to thank Computer Science Laboratory (CSL) of Fukuoka Institute of Technology (FIT), Japan and Japan Society for the Promotion of Science (JSPS) for supporting partially this work.

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