

# Easy enjoyable effective automated practice and test system

Takao Shimomura, Muneo Takahashi, Quan Liang Chen, Nhor Sok Lang, and Kenji Ikeda

**Abstract**—E-Learning is not almighty, nor can it teach everything.

On the other hand, e-Learning is very suitable for playing such auxiliary roles as help teachers estimate the effectiveness of their lessons or help students know the current status of their abilities. This paper presents an open and customizable automated practice and test system, which teachers can easily administer, and with which students can enjoy studying. The paper also describes the implementation of the Apty system. A teacher can install the system only by entering a password for the Apty administrator. The installation and complicated settings of a Web server and a database server are all automated. Students can view a list of all subjects only by accessing the homepage of the Apty system, and they can begin to practice any subject without login.

**Keywords**—Customizable, examination, open e-Learning, practice, web applications.

## I. INTRODUCTION

E-Learning is not almighty, nor can it teach everything [1]-[3]. The sensation of frustration, loneliness and confusion, which some participants express, is the result of both, lack of involvement and participation of some students as their peers opted out, and lack of involvement and feedback on the part of the facilitator. It is said that women are more strongly influenced by perceptions of computer self-efficacy and ease of use, and that men's usage decisions are more significantly influenced by their perception of usefulness of e-learning. We believe that what are most required for students to study a subject and understand it as far as they get satisfied are a good teacher and a good book (a textbook or a reference). It is a good teacher who teaches us plainly enough and step-by-step. It is a good book that helps a student when he or she reviews the subject and wants to understand it more deeply. On the other hand, e-Learning is very suitable for playing such auxiliary roles as help teachers estimate the effectiveness of their lessons or help students know the current status of their abilities.

Currently, there are a variety of e-Learning systems in the world [4]-[8]. In addition, JST in Japan [9] provides about forty thousand pieces of abundant courseware for free of charge. The

courseware consists of such subjects as space, earth science, meteorology, biology, physics, and chemistry, which can be used at elementary schools, junior high schools, and senior high schools. For example, in the courseware of sound that makes full use of multimedia such as animation and video, we can visually understand how sound is transmitted as waves. The computer graphics reproduces how the Himalaya Mountains were constructed in ancient times. MIT OpenCourseWare project [10] provides courseware that includes over 1400 subjects in the curriculums of faculties and graduate schools through the Internet for free of charge. We can browse those syllabuses that consist of learning objectives, measurable outcomes, assessment methods, scheduled exams, subject meetings, recitations, course materials, assignments, and so on. In addition, we can view professors' lecture notes that include slides and videos. We can also study subjects by listening to professors' lectures while watching slides. As for the textbooks published by MIT Press, we can see the contents of their online versions by tracing those in turn using Web browsers. MERLOT [11] collects courseware from all over the world, stores their locations and classification information in a database, and makes them public for free of charge. At present, about 15,000 pieces of courseware are registered. The quality of the courseware is very high because they are reviewed before registration. The rating of courseware made by referees and the comments made by the people who browsed the courseware are also put up. All the pieces of courseware are made by using multimedia and advanced programming techniques.

However, we have difficulties in installing and administrating conventional e-Learning systems. Moreover, it may take a lot of time to develop the contents of courseware, or we might be forced to use ready-made courseware. Students need to perform several operations to reach the pages of interest because of the complexity of e-Learning systems.

This paper presents an open and customizable automated practice and test system, which teachers can easily administer, and with which students can enjoy studying. The paper also describes the implementation of the Apty system. A teacher can install the system only by entering a password for the Apty administrator. The installation and complicated settings of a Web server and a database server are all automated. Students can view a list of all subjects only by accessing the homepage of the Apty system, and they can begin to practice any subject without login.

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Fig. 1 Example of Apty homepage

(R3-3) Any code can be specified for text files to be uploaded or downloaded.

## II. REQUIREMENTS

The aim of this system is to promote students' motivation so that they can enjoy studying, and enable teachers to easily administer the system without any difficulties. To fulfill this aim, we take the following requirements into account:

### A. Requirement 1: Easy and open

(R1-1) Installation and administration of the system should be easy.

(R1-2) An ordinary computer user can install and administer the system. They do not have to be a super user (root).

(R1-3) Without login, students can view a list of all subjects and they can begin to practice any subject. This facility will encourage students to get interested in the other subjects they are not currently studying.

### B. Requirement 2: Enjoyable and stimulating

(R2-1) The top 10 scores appear in a subject homepage, and anyone can see these scores without login.

(R2-2) It should be possible for anyone to get the top score. This will cause the order of top 10 scores to change very often. This makes students study hard by competing with each other [12].

### C. Requirement 3: Helpful and Customizable

(R3-1) Students can ask their teachers anonymously. Even if students hesitate to ask teachers directly, they can ask them without constraint.

(R3-2) Messages and images can be localized to any language in the world.

## III. APTY SYSTEM

### A. Introduction to the Apty system

This section describes the outline of the Apty system. Fig. 1 shows the homepage of the Apty system. To make it possible for anyone to begin practicing any subject without login, we arrange a list of subjects in the left frame of the Apty homepage, and arrange the homepage of each subject in its right frame (R1-3). When a student clicks on a subject name displayed in the subject list in the left frame, the homepage of the corresponding subject is displayed in the right frame. In the top frame of the subject homepage, students can view subject information or take exams. In the bottom frame, students can view the practice scores. When they click on the "Practice" button displayed in the top or bottom frame, they can begin to answer questions for practice. By this facility, anyone can view the examples of questions of the subject they are interested in, and come to understand what they can learn from that subject without registration of courses.

When a student clicks on the "Ask question" link in the top frame, he or she can ask the teacher in charge of that subject anonymously (R3-1). As shown in Fig. 2, this system is basically open to anyone. Anyone can access this system to start practicing, see top 10 scores of examinations and practice, ask questions, and see feedback messages. On the other hand, only registered students are allowed to take examinations, review, answer a questionnaire, and see their scores.

At present, the homepage of subject Trivia is shown in

English. Actually, all messages and images the Apty system displays can be localized to any language as described in Section IVD (R3-2). In addition, when we upload or download text files that consist of the Apty home message, a subject home message, or a subject feedback message, we can use any code for that country.

Fig. 3 shows the Apty system configuration. The Apty system consists of a Web server (Tomcat) and a database server (Postgresql). The database server administers aptydb database that stores the subject information of each subject, and subject databases, each of which is created when a subject is created. Students use a Web browser to access the Web site of the Apty system.

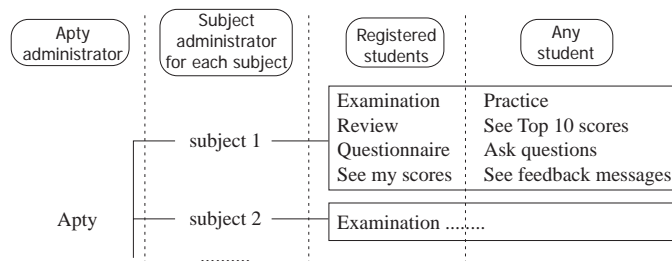


Fig. 2 Open system for any student

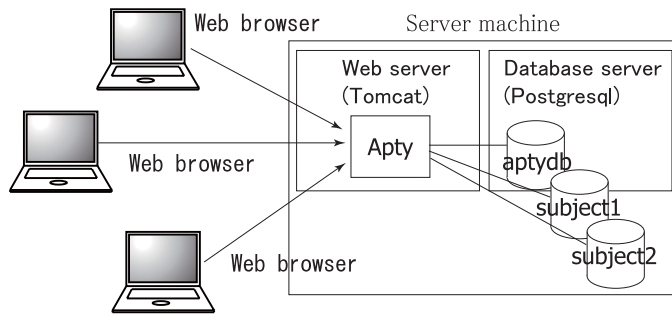


Fig. 3 Apty system configuration

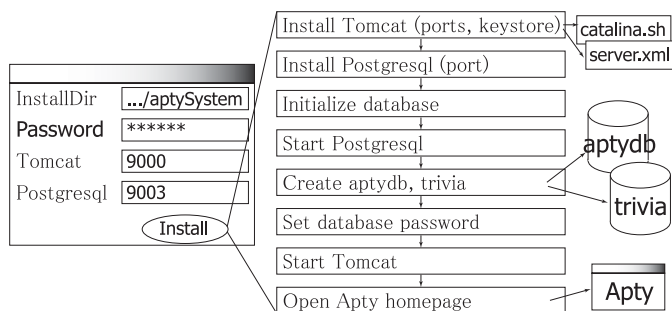


Fig. 4 Installation method for the Apty system

#### B. Installation method for the Apty system

We have developed an installation tool to make it easy to install the Apty system. As shown in Fig. 4, a teacher can install

the Apty system only by entering a password as the Apty administrator (R1-1). A default directory will be automatically displayed for an installation directory. As for the port numbers of Tomcat and Postgresql servers, this tool automatically finds the appropriate vacant ports to display their numbers. To make it possible for an ordinary computer user to install and administer the system, the system ports' numbers such as 80 (http) and 443 (https) are not used at default setting (R1-2).

When a teacher clicks on the "Install" button, installation begins as shown in Fig. 4. Unlike the conventional systems, this tool sets appropriate port numbers for Tomcat and Postgresql servers, creates a subject database that includes an example subject Trivia, sets the database password the teacher specified, starts the Apty system, and then opens the Apty homepage by starting a default Web browser.

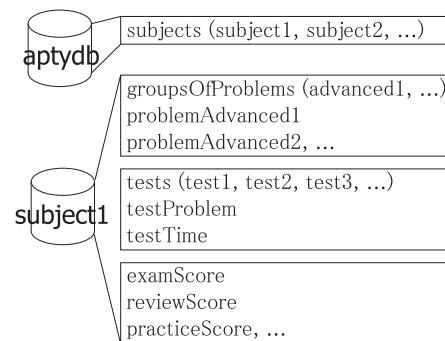


Fig. 5 Database system configuration

## IV. IMPLEMENTATION

### A. Administration method for subjects

The Apty system uses aptydb database that stores the subject information of each subject, and subject databases, each of which is created when a subject is created. Any number of subjects can be created by the Apty administrator, who installed the system. Fig. 5 shows the database system configuration. The aptydb database has DB table "subjects", which contains a subject name, subject no., subject icon, subject locale, subject administrator ID, subject administrator password, and so on for each subject. A subject database has such DB tables as a problem group, problems, tests, testProblem, testTime, examScore, and so on. The problem group DB table contains a problem group name, a problem group title, the number of choices, and so on for each problem group. The problem DB table is created for each problem group and contains the fields of a problem no., problem statement, choices, chapter, section, advice, and so on. The testProblem DB table defines which problems of each problem group will be set for each test. The testTime DB table defines when each test starts and ends.

For a security reason, we have designed the system so that these DB tables can be accessed only by the Apty administrator. Any teacher who is given a subject administrator ID and password by the Apty administrator becomes the

subject administrator of the corresponding subject, and he or she can control all information of that subject. However, they can only access these DB tables through the Apty system by using a Web browser.

As described in Section IV D, to make it possible to customize home messages, styles and images for each subject, each subject has its own configuration files independently. As shown in Fig. 6, each time a subject is newly created, its messages, styles, images are generated by copying the models of those from the Apty configuration directory.

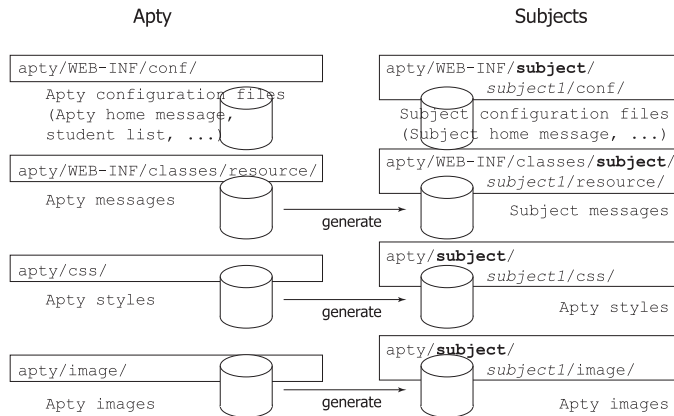


Fig. 6 Administration method for subjects

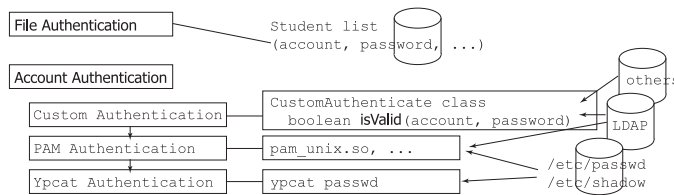


Fig. 7 Student authentication methods

### B. Student authentication methods

When students take an exam, they need to be authenticated by login. In addition, when they want to review the questions they answered wrongly, or when they want to see their exam scores, they need to be authenticated. In the system, we have developed authentication methods as shown in Fig. 7. First, the Apty administrator registers students in the student list file. The student list file stores the account names, passwords, courses, and full names of the students. The authentication methods this paper presents are generally classified into two categories, file authentication and account authentication.

In the file authentication, students are authenticated by the account names and passwords stored in the student list file. In the account authentication, we can authenticate students more flexibly. The account authentication consists of custom authentication, PAM authentication, and Ypcat authentication. In the custom authentication, a user can determine how to authenticate students. The user can implement any authentication method by defining the isValid() method of the CustomAuthenticate class. In the PAM authentication, the PAM (Pluggable Authentication Modules) is used. In the Ypcat authentication, students are authenticated by the account information that is obtained by the "ypcat passwd" command on a server machine where a NIS service is available. This Ypcat authentication makes it possible for an ordinary user (not a super user) to administer this system (R1-2).

To make it unnecessary to specify the authentication method, the Apty system automatically judges which authentication method is available in turn in the order of custom, PAM, and Ypcat authentications, and determines an appropriate one of them (R1-1). The authentication method in use is shown in the left bottom frame of the Apty homepage (See Fig. 1).

Seq No.	Item	Value	Constraints
1	Problem no.	No. 1 (Used in setting of test problem)	Integer >= 1
2	Problem title	Height of salt	Up to 40 characters
3	Problem	<div>HTML View HTML Code</div> <p>If we pile up all the salt contained in the sea on the surface of the earth, how high will it be?</p>	<div>HTML View HTML Code</div> <div>Rich text editor toolbar with icons for bold, italic, underline, link, unlink, list, etc.</div>
4	Choice 1 <input type="radio"/> Correct	<div>HTML View HTML Code</div> <p>1 m</p>	<div>HTML View HTML Code</div> <div>Rich text editor toolbar</div>
5	Choice 2 <input type="radio"/> Correct	<div>HTML View HTML Code</div> <p>5 m</p>	<div>HTML View HTML Code</div> <div>Rich text editor toolbar</div>

Fig. 8 Creation of problems with HTML

### C. Web operation methods

To make it easy to create questions using a Web browser, we have prepared two edit modes, HTML view mode and HTML code mode. In the HTML view mode, while teachers are viewing the contents that will be actually displayed in a Web page, they can edit them. For example, in Fig. 8, we change the background color of the text "sea" to blue. We first select this text with the mouse. When we then click a bucket icon from the edit menu in the right column, a color palette appears. As soon as we choose a blue color cell, the background color of the text turns blue. We can see the result immediately because this system uses JavaScript and does not communicate with the server. In the HTML code mode, we can enter more complicated HTML code directly, and we can easily make sure of the result by switching from the HTML code mode to the HTML view mode.

To make it easy to create filling-in questions, we have prepared a filling-in icon as an edit menu item. In addition to the fields of a problem statement and choices, we have prepared such fields as chapter, section, and advice so that teachers can indicate the chapters and sections of the textbooks they want students to review, and teachers can give some appropriate advice when students answer questions wrongly.

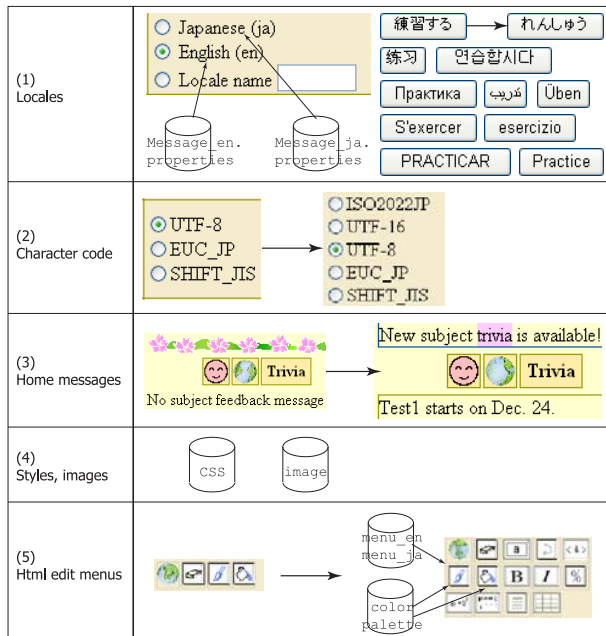


Fig. 9 Customization of the Apty system

### D. Customization of Apty homepages and Apty system itself

Customizing the Apty homepage and subject homepages is very important for users. The Apty system makes it possible for users to customize several items as shown in Fig. 9. First, (1)

users can set a language in which the Apty homepage or subject homepages are shown. To do this, we have prepared message property resource files for each locale (See Fig. 6).

(2) Users can select code when they upload and download subject home messages and feedback messages (R3-3). (3) Users can display the Apty home message that is common among all subjects, and a subject home message that pertains to each subject in a subject homepage. (4) The system makes it possible for teachers to design styles and images with which a subject homepage is displayed for each subject (See Fig. 6). (5) Users can freely define edit menu icons that are used when they create questions and subject home messages. At default setting, the Apty system provides 14 edit icons that are considered to be commonly used. However, users can add, change, and delete edit icons by modifying the menu file (which depends on the locale). This menu file defines menu item names, icon file names, options, HTML code to be inserted, and so on.

Table I Set problems for a series of tests

Test	Problem group	Number of set questions	Problem range
jip1	fundamental	5	1-70
jip2	fundamental	5	1-70
jip3	fundamental	5	1-70
jip4	fundamental	3	1-70
	intermediate	1	1-15
	advanced	1	1-10
jip5	fundamental	3	1-70
	intermediate	1	1-15
	advanced	1	1-10
practice	fundamental	5	1-60

## V. EVALUATION

We have been making use of the Apty system since 2002 in classes at university to check the effects of the classes and to promote students' motivations. We here briefly describe the results of these experiments. We prepared 4-choice questions, which were classified into 3 problem groups such as fundamental, intermediate, and advanced. The numbers of the questions were 70, 15, 10, respectively, and 95 in total. We administered a series of 5 tests (jip1 to jip5) as shown in Table I. For each test, we set 5 questions, and let the answer time be 20 minutes. For example, for the first test (jip1), 5 questions were given at random among 70 questions of the fundamental problem group. As the class was proceeding further, some of the questions in the intermediate and advanced problem groups were given in the fourth test (jip4) and the fifth test (jip5).

For practice, 5 questions were given at random among 60 questions of the fundamental problem group. The answer time was set to 25 minutes, which was a little longer than that of the tests. Anyone was able to begin to answer the questions for practice without login. We administered these 5 tests from the



beginning of June to the beginning of July. A little while after the class started, some students gradually appeared who tried to begin practicing. Immediately before the first test was given, a lot of students did practicing again and again. Although we had 98 students in the class, they tried to practice 3790 times in total (See Fig. 10). We can see that the average scores of practices were gradually being raised.

The Apty system enabled students to view the top 10 scores and the distribution of scores for the current test and the previous test in a subject homepage at any time as shown in Fig. 11 (R2-1). It was possible that some students could join in the top 10 of the current test even though they did not join in the top 10 of the previous test, because the top 10 scores were shown based on not the total scores but the scores of each small test (R2-2). In the case of practicing, the top 10 scores are also displayed in real time in the bottom frame of the subject homepage. Because anyone can join in practicing without login, students' names are not shown in the top 10 scores for practice. On the other hand, the time a student completed practicing is recorded up to hours, minutes, and seconds.

Therefore, if someone joins in the top 10 scores, they can know that it is actually their own score. Or they might come to notice that it is the score of the student practicing on the next computer. Judging from the top 10 scores of practices shown in Fig. 12, it seems that practicing was done during not only the class time but also other times. When we check the top 10 scores and the dates very carefully, we can know that there were some students who came to university to do practicing even on holidays.

Fig. 13 shows the histogram of review completion, which indicates what percent of students completed reviewing the questions they had answered wrongly in the tests. Students can review those questions later any number of times. If there are some questions they have not yet reviewed, they can easily check how many those questions are left. From Fig. 13, we can know that 71 out of 102 students completed reviewing at 91 to 100 %. It seems that almost all students did their best to review the results of these 5 tests.

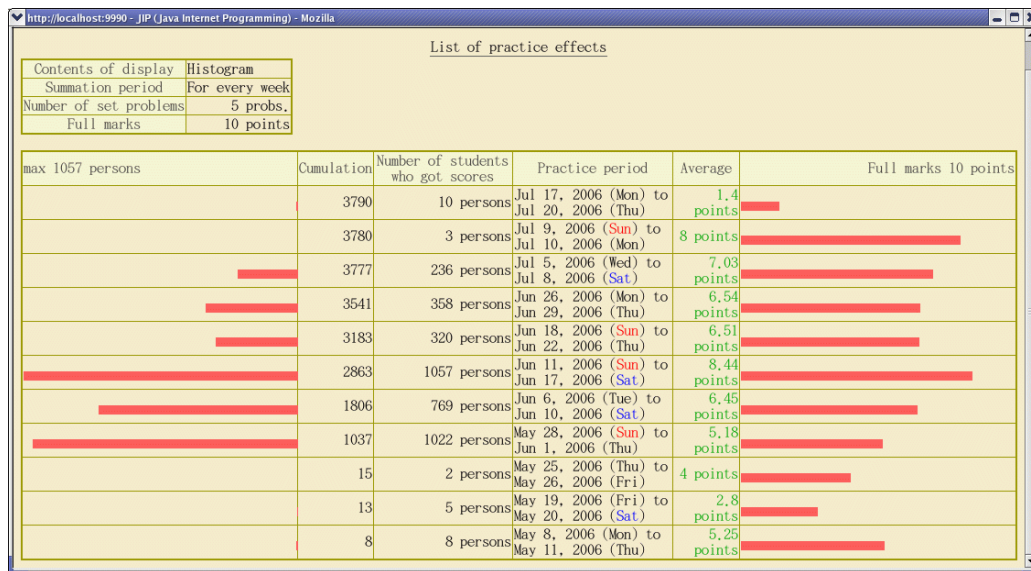


Fig. 10 Effects of practices

## VI. CONCLUSION

This paper has presented the Apty system with which teachers can easily create questions through a Web browser, and can automatically administer exams and practices. Although e-Learning is not almighty, we were able to make sure that students' ability of understanding and motivation of learning were promoted in the classes at university where the

Apty system was utilized. As for the professors, the Apty system turned out very useful and helpful, because students studied hard voluntarily through the free practices and professors were able to save some time that would be required to administer the tests. In the future, we are going to enhance such functions as promoting communications between students and their cooperation in learning.

Examination title	Teacher	Number of examinees	Number of set problems	Full marks	Average	Lowest	Highest
Jip Test5		98 persons	5 probs.	10 points	6.65 points	2 points	10 points

Rank	Score	Student ID	Name
1	th10 points	is0528	Angela Madako
1	th10 points	is0530	Susan J. Jones
1	th10 points	is0526	Adam Juskiewicz
1	th10 points	is0518	Richard King
1	th10 points	is0579	Ann Lind
1	th10 points	is0516	Camilla Magnusson
1	th10 points	is0517	Grace Masagbor
1	th10 points	is0573	Mark McCrohon
1	th10 points	is0554	Marco Petrick
1	th10 points	is0512	Olivier Pivert

Fig. 11 Top 10 scores for exams

Rank	Score	Score date	Time
1	th10 points	Jul 10, 2006 (Mon)	9:15:33 PM
1	th10 points	Jul 9, 2006 (Sun)	7:44:48 PM
1	th10 points	Jul 6, 2006 (Thu)	7:52:25 PM
1	th10 points	Jul 6, 2006 (Thu)	7:40:35 PM
1	th10 points	Jul 6, 2006 (Thu)	7:31:16 PM
1	th10 points	Jul 6, 2006 (Thu)	7:24:29 PM
1	th10 points	Jul 6, 2006 (Thu)	12:53:32 PM
1	th10 points	Jul 6, 2006 (Thu)	12:51:37 PM
1	th10 points	Jul 6, 2006 (Thu)	12:51:29 PM
1	th10 points	Jul 6, 2006 (Thu)	12:51:19 PM

Fig. 12 Top 10 scores for practices

Review rate	Number of students	Cumulation
0 to 10 %	7 persons	102
11 to 20 %	1 persons	96
21 to 30 %	3 persons	94
31 to 40 %	1 persons	91
41 to 50 %	2 persons	89
51 to 60 %	4 persons	86
61 to 70 %	5 persons	84
71 to 80 %	6 persons	79
81 to 90 %	2 persons	73
91 to 100 %	71 persons	71

Fig. 13 Histogram of review effects

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