STUDIES ON DEVELOPMENT OF WEB-BASED INTEGRATED LEARNING AND EDUCATION SUPPORT SYSTEM

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ABSTRACT. *This paper aims at the development and improvement of the learning and education support system which cooperates with the grades and attendance information of the student managed by the existing academic affairs system. That is, it is developed as an integrated web application that has not only students grades management, but also attendance management, achievement degree evaluation for JABEE, and interview records.*
Keywords: Integrated learning and education support system, Big data, Web-application

1. **Introduction.** The development of online databases such as teaching systems at universities is rapidly advancing, and commercial software that implements various services such as personal information, course subjects registration, and grades management as web applications have been developed and introduced at many universities [1, 2, 3]. However, many of these systems aim at the efficiency of office work, so there is a problem that necessary information cannot be obtained from the viewpoint of student guidance by the university faculty members. For example, it is easy to obtain the grades and attendance of the subject registered to the lecturer in the academic affairs system. The grades and attendance of registered students can be also easily referred to. However, it is not possible to obtain an overview of attendance and grades for each grade. Furthermore, if the collected learning information can be analyzed, it will even be possible to know teaching methods and coping methods according to the students [4, 5]. In order to cope with these problems, software modifications of the web application are required. That is, software development vendors provide as individual paid add-on these functions.

Information management such as student's grades and attendance, records of interview histories is very important in student guidance [6, 7, 8]. In our department, students information such as grades, attendance, and contacts is provided through the file sharing service from the academic affairs system. In addition to this information, students guidance is carried out using histories of interview records by the university faculty member. However, the information such as grades, attendance and interview records is usually stored separately in each system. Teachers may not be able to provide appropriate guidance due to the lack of integrated information. Therefore, it is considered that efficient and substantial student guidance becomes possible if this information can be referred and managed unitarily.

This paper aims at the development of a learning and education support system which integrates the information such as grades and attendance stored in the academic affairs

system and the information such as interview history kept in the department unit. Concretely, in the proposed integrated learning and education support system, in order to grasp the student status of the learning and the education, course registrations information stored in the academic affairs system, attendance record, and interview record are integrated as a web application. For example, it becomes possible to list the attendance information of all the course subjects for each school grade, the attendance status in the focus to recently two weeks for each school grade, the attendance status in the past semester and the credit acquisition status which considered to move up to the next grade conditions for each course. Specifically, Section 2 describes the current leaning and education support systems, and introducing our proposed system overview in Section 3. Section 4 describes the application framework, the database structure and the design of the user interfaces, and an example of actual operation as a web system is introduced in Section 5. Section 6 summarizes the paper.

2. **Learning and Education Support.** Students from various areas are accepted in the university, and there are also many students who start living alone in accordance with the advance to the university. Therefore, it is an important problem to discover the students whose tardiness and absence increase by the factors such as the collapse of the life rhythm and the poor physical condition and to examine the countermeasures early. Confirmation of the attendance situation is important as a means to know such students quickly.

Since about 10 years ago our department had started regular student interviews in order to improve the quality of student guidance. In interviews aimed at teaching and living instruction by teachers, a Microsoft Word file for each student to share information is used. At the same time, our department staffs had been shared attendance information among course subjects with Microsoft Excel. That mechanism has recorded the attendance of subjects in charge of each sheet and grasped the statics by the macro program. Students who tend to be absent are possible to detect from this method. However, there is no distinction between consecutive and fragmented absences. In addition, there was a problem of the continuity in the record, since it was managed as a separate file every school grade and every fiscal year. After that, the academic affairs system was enhanced, and not only the grades but also attendance was also managed on this system. However, there remain problems that various information can be viewed only by the class in charge or individual student who is a registered unit in the academic affairs system, and information such as grades and attendance cannot be viewed comprehensively.

Therefore, if this information can be controlled in an integrated manner, it will be possible to easily refer to grades, attendance situations, and previous interview records at the time of student interviews. Furthermore, it becomes even possible to visualize the relation between grades and attendance. This information is very useful for students guidance. For example, it is considered that it is useful for the students themselves to understand how the present attendance situation changes in comparison with the same term of the previous year or the previous semester, and how it affects the grades. As a result, the teacher can provide substantial guidance.

3. **Integrated Learning and Education Support System.** In the previous section, the existing academic affairs system and the student guidance support framework of our department were described, and improvement measures were examined from the viewpoint of student guidance by teachers. This section describes the requirements definition of the proposed integrated learning and education support system. Also, the method to utilize it as a self-evaluation in each semester and study plan by themselves is examined.

Firstly, in the ordinary registration of academic affairs system, students register the subjects they plan to take in the form of a timetable. At that time, the registration is advanced by referring to the subject type (required or elected subjects) and the subject

category (liberal arts, engineering basics, various specialized subjects, and so on) on the system. However, for example, in the stage in which the selection of the specialty course has not been decided, it is difficult to plan the subjects taking required or elected subjects set for each course into consideration. Also, because the subjects required to achieve unique learning and educational goals such as JABEE[1] are complex, it may be not possible to describe registration restrictions or achievement conditions on the academic affairs system.

Therefore, students need to register while referring to the syllabus and course requirements. In addition, there are problems that the syllabus is operated in the separate system, and since the credit calculation considering promotion requirement and graduation requirement by the course is not possible. Thus, students have been collecting various information by themselves or depend on the course guidance provided by department staff members.

From the above, an integrated learning and education support system is developed as a PHP framework web application to smoothly advance the course guidance by teachers and the study plan by students. The proposed system has each information as databases such as syllabus information for each subject, the number of credits for each course, and information on the learning education goal in JABEE.

4. **Construction of Learning and Education Support System.** This section describes the specifications of the proposed learning and education support system, the configuration of the application framework, user authentication and access control.

4.1. **System specification.** The functions provided by this system are, as shown in Figure 1, confirmation of grades, entry of attendance status by subject, confirmation of attendance status, syllabus reference and registration, interview record, confirmation of JABEE achievement status. Access to each function requires LDAP (Lightweight Directory Access Protocol) user authentication based on user access control. The display contents and editing range of each function are set according to the user level. The language used for development is the PHP, CakePHP as an MVC framework, and MySQL as a database [9, 10].

4.2. **Application framework and MVC model.** The CakePHP framework, one of the frameworks in PHP[2], adopts MVC[3] model as a software design model and develops the whole program by dividing it into three elements of Model, View, and Controller (Figure 2). First, the Model describes the tables in the database and the connections between the tables and specifies the methods to be called from the Controller and the View. The View communicates input events from the user to the Controller, gets the relevant data from the Model, and updates the Web pages output. In the Controller, the requests of input event processing from the View are in charge of the Model method processing according to the action from the user.

The CakePHP has conventions such as directory structure, file names, and database elements. For example, if the table name in the database is Users as shown in Figure 2, the corresponding Model file is uniquely determined to be User.php. Identically, a source file name of the Controller is UsersController.php, and that of View is User.ctp. Though the naming conventions are complicated, various security related to the web application

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[1]Japan Accreditation Board for Engineering Education, in accordance with the concept of Washington Accord, Seoul Accord for Computing and IT-related education programs and UNESCO-UIA.

[2]PHP: Hypertext Preprocessor is a popular general-purpose scripting language that is especially suited to web development.

[3]MVC is an application design model comprised of three interconnected parts. They include the model (data), the view (user interface), and the controller (processes that handle input).
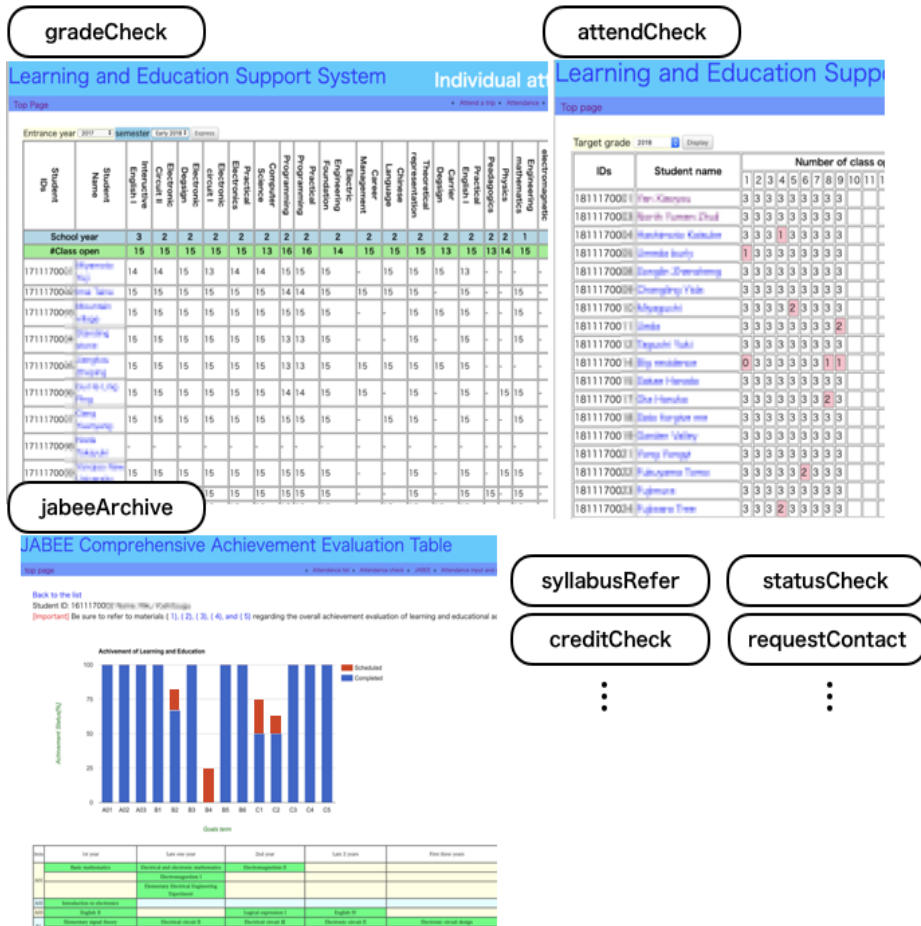
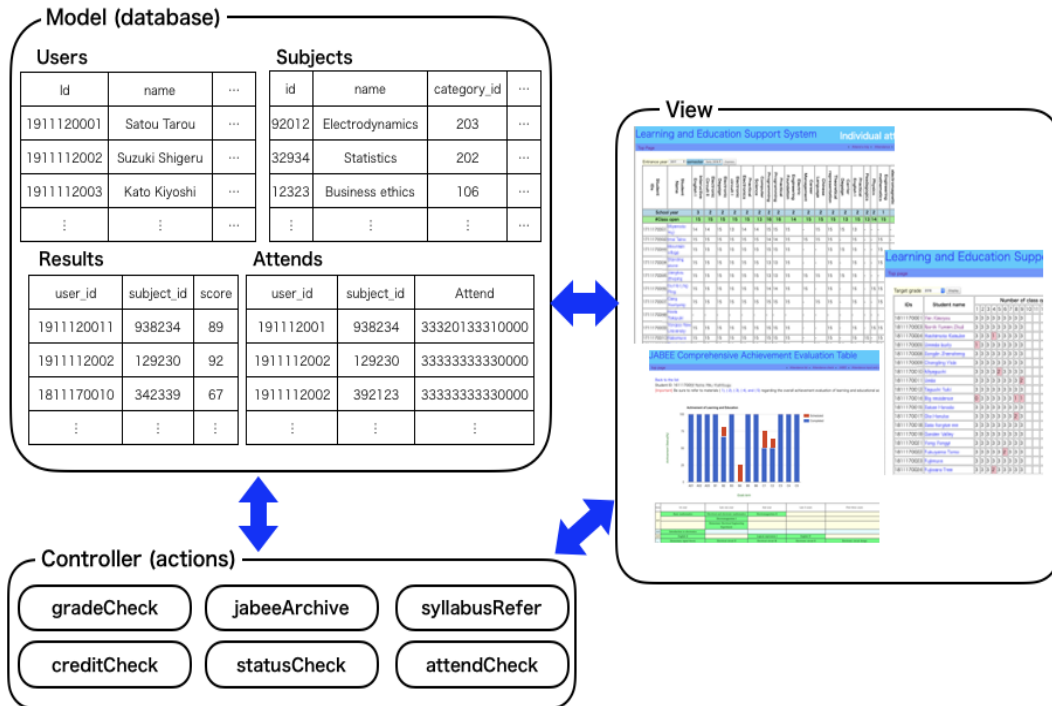FIGURE 1. Functional diagram of proposed system

FIGURE 2. Overview of MVC model

is secured, if they are observance. In addition, the maintainability and reusability of the code are considered, and as a result, the development efficiency improves.

As described above, in the web application development in the CakePHP, the source codes could be maintained at constant qualities based on the MVC model and the conventions. At the same time, improvement in development efficiency, maintenance and security are also guaranteed.

4.3. **Database design and association between tables.** Figure 3 shows the table structure of the database adopted in our proposed system. In the CakePHP framework, there is a function called association which associates tables in database by primary key and foreign key. This feature is automatically defined in the Model if the element name of the database table according to the convention. In other words, a Model (database table) having a primary key corresponding to a foreign key in another Model is defined *hasOne*. Similarly, a Model having a one to many relationships is defined *hasMany* and a Model having only foreign key is defined *belongsTo*. *Associations* are thus defined as relationships between tables in a database.
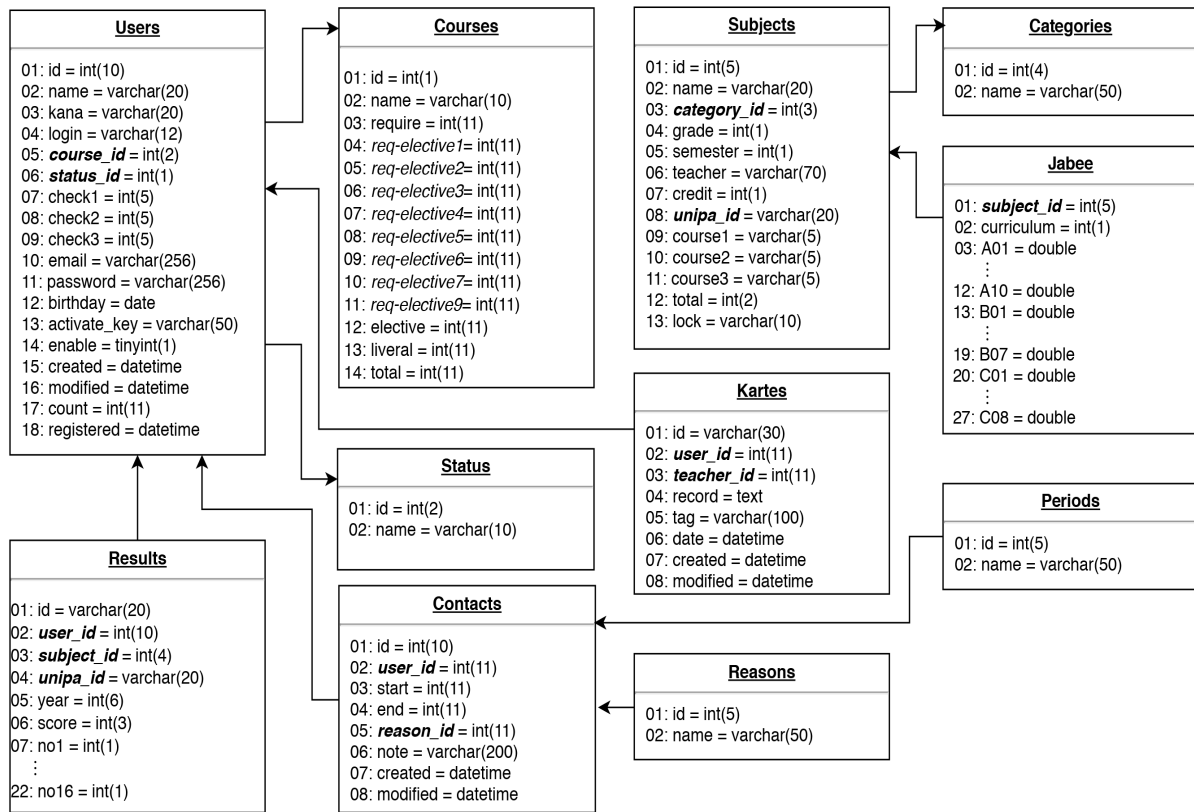
FIGURE 3. Database structures of proposed system

Consider the association for the case where the table element id of the Users/Subjects is defined as the primary key as shown in Figure 4, and the student number (user_id) and course subject number (subject_id) are defined as the foreign key for the Results table. Generally, as shown in the figure, the elements of each table have relationships. In other words, by assigned student number (user_id) and course subject number (subject_id) as elements of Results table as foreign keys corresponding to Users/Subjects table with id element representing the primary key in CakePHP, relevance is defined automatically. At this time, the hasMany attribute as foreign keys is passed to respectively the Users model and Subjects model as the role of the student number (user_id) and subject code (subject_id) of the Results model as foreign keys. In response to this, *belongsToUsers*
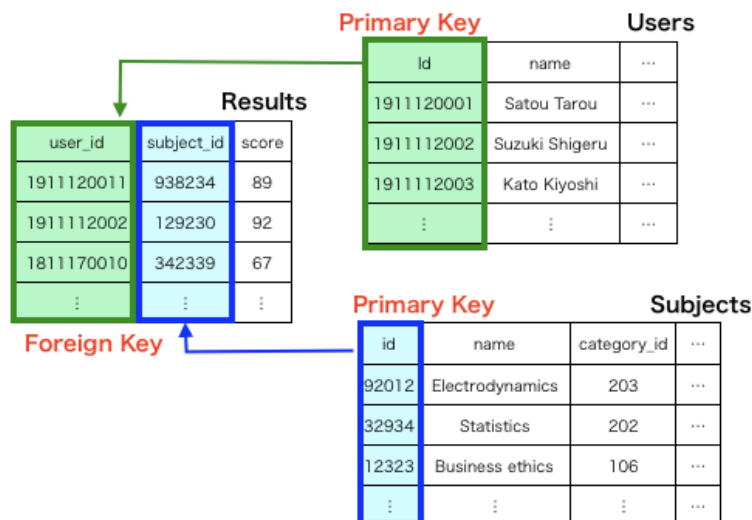
FIGURE 4. *Association* rule between tables on the database

and *belongsToSubjects* are also defined as corresponding to the Results model. By specifying the association, when the Results model is queried, the user and subjects fields corresponding to the foreign key are recursively acquired.

Since the association described above automatically recursively searches the elements of the tables in the belonging relationship, the join definition required in the usual database query becomes unnecessary. For this reason, developers can easily obtain the necessary information by simply queries.

4.4. **User authentication and access control.** First of all, in the standard user authentication implemented in CakePHP called *AuthComponent*, the password information is stored directly in the database by plain or encrypted text. Therefore, the choice of encryption method and the code handling of internal plaintext password may lead to system vulnerability. Next, even if the URL as browsing the personal information is requested directly without through the login page, the appropriate user access control corresponding to the user level needs to be maintained by the certainly performed authentication process.

Regarding the former, *LdapAuthComponent* was developed as a new component for the CakePHP corresponding to LDAP authentication widely used in the various operating systems. About the latter, the CakePHP framework provides functions to add common processing before and after all actions called filter chain. That is, by configuring the user authentication process using *LdapAuthComponent* in the filter chain function *beforeFilter()*, it becomes possible to perform the user authentication process not only to all existing pages but also to pages to be created in the future.

The flow of authentication diagram of the *LdapAuthComponent* using a *beforeFilter()* function is shown in Figure 5. In this figure, (1) for the URL request sent from the user, (2) the authentication process is called by *beforeFilter()* which is a filter chain. Then, (3) evaluating whether the user is authenticated, (4) if the user is authenticated and satisfied authority, the request page can be browsed, and (5) when the user is not authenticated, the login screen is displayed. When the wrong id or password is entered, the login screen is displayed again.

5. **Implementation of Custom View Function for the Proposed System.** In this section, the functions of the actual operating proposed system are described. In Figure 6, on the attendance confirmation function, attendance information acquired from the academic affairs system can be displayed not only by individual and subject but also
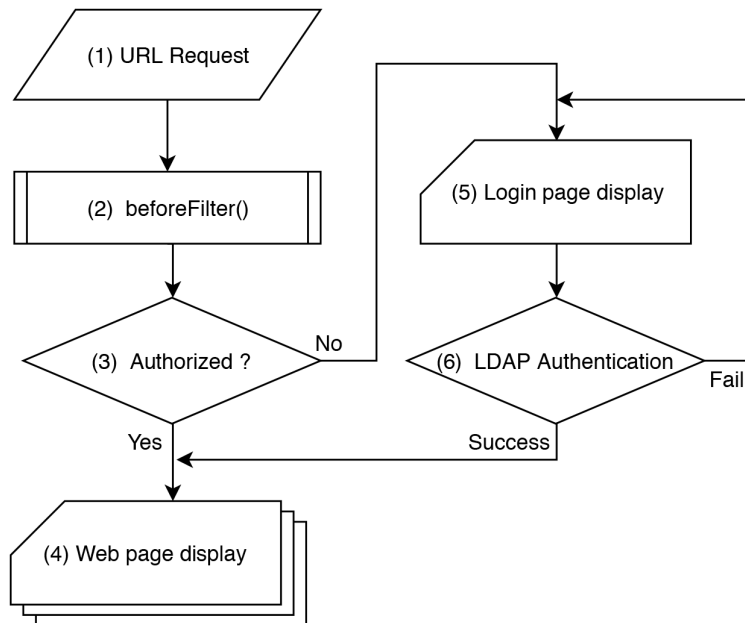
FIGURE 5. Overview of the LDAP user authentication feature

FIGURE 6. Screenshot for the attendance status of the same grade students

by grade and past year. From this screen, the attendance summary and their difference between lectures can be confirmed. However, it is still difficult to analyze the tendency of absence and lateness because the day of the week and periods cannot be distinguished.

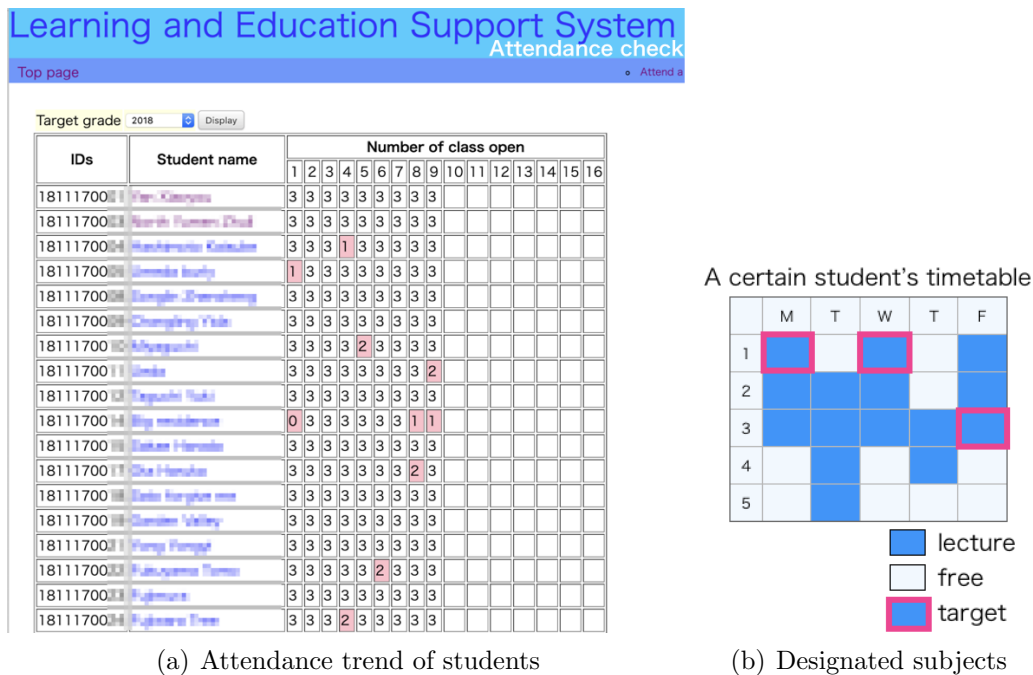(a) Attendance trend of students   (b) Designated subjects

FIGURE 7. (color online) Screenshots of student attendance trends and examples of the relationship between student timetables and the three designated subjects

Figure 7(a) shows the attendance check-list by three subjects assigned in advance for each student. In this figure, only the attendance of three subjects specified in advance for each student timetable as shown in Figure 7(b) is extracted and displayed. For these subjects, for example, the compulsory subjects opened in the first period of Monday are selected. When the number of attendance is less than two times, that cell is filled in pink. As a result, it can be found the student has been losing attendance rapidly in the last two weeks.

6. **Conclusion.** In this paper, the learning and education support system which integrates the information such as grade and attendance stored in the academic affairs system and the information such as interview history kept in the department unit was proposed. Namely, in the proposed system, registration information stored in the academic affairs system and attendance record, and interview record were integrated as a web application.

As a result of implementing the proposed system, it became possible the customized freedom function that could not be realized with conventional academic affairs systems. For example, it became possible to list the attendance status in the last two weeks for each grade, the attendance information of all the courses taken for each student, the attendance status in the past semester and the degree acquisition status, etc.

As a future research subject, it is considered to analyze the learning situation and action pattern of the student by cooperating with the proposed system [11] which collects the user location history of the student from the wireless access point connection logs.

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