A Method That Makes WBL Anti-ubiquitous in Practice and Its Support System

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***Abstract*—"Anti-ubiquitous" is the opposite concept to "ubiquitous" and refers to placing restrictions on time and location. We have conducted research to eliminate the "stagnation in study activities brought about by the ubiquitousness of learning content on the Web" - an intrinsic problem of WBL (Web-based Learning) - and to make WBL more effective and substantial. However, there are problems that are difficult to solve technically and anti-ubiquitouess in WBL is not a simple matter. In this study, we propose, through operational innovations, a method for functionalizing anti-ubiquitousness in WBL and a simple system for supporting end users. Today there are multiple varieties of good learning content, such as OCW (OpenCourseWare) and MOOCs (Massive Open Online Courses), and significant implications could be seen by creating a method of functionalizing WBL anti-ubiquitousness and providing a support system has major significance.**

***Index Terms*—Anti-ubiquitous learning, web-based learning, learning management system.**

I. Introduction

WBL (Web-based Learning) [1] is a highly convenient type of ubiquitous learning that is available "anytime, anywhere, by anyone," but this fact often leads to stagnation in learning activities. The priority of learning activities without any restriction tends to lower and this lack of restrictions tends to mean that being able to study "anytime, anywhere" encourages the postponement of learning activities.

We have been searching for a form of WBL anti-ubiquitousness that eliminates the "stagnation of learning activities brought about by ubiquitousness and make WBL more effective and substantial. The anti-ubiquitouness espoused by us is the opposite concept to ubiquitouness, where we intentionally place restrictions on time and place. When this anti-ubiquitous learning [2] is applied to e-learning, it concentrates the awareness of the student and contributes to a more effective and substantial learning experience.

However, WBL anti-ubiquitousness is not a simple matter. In other words, placing restrictions on the time and location of learning content means controlling access to learning content according to time and location. These are completely different to the normal access controls on Web content. Recently, the security functions of the Web browser have been the bottleneck, and making learning content on the Web anti-ubiquitous continues to be a difficult process.

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Based on the above, we have proposed a method of covering the technical difficulties involved in WBL anti-ubiquitousness on the operational side. More specifically, we have introduced an evaluation of the student's study history by the study supervisor. In other words, rather than making it so the student can only study at specific times and locations, an anti-ubiquitous function is provided where the student is evaluated well for studying at a specific time and location.

Furthermore, in this study, we have also used the knowledge obtained through research until now to newly propose a system to support WBL anti-ubiquitousness. This is a simple system aimed at the end user and is a simple program with a completely different concept to the prototypes we have created until now. It does not require the use of a server or database.

The structure of this paper is as follows. In Section II, we discuss the background to this study and the anti-ubiquitous learning espoused by us. Based on this, we discuss WBL anti-ubiquitousness in Section III. Furthermore, in Section IV we consider a process for the practical implementation of anti-ubiquitous WBL, and the system to support this is discussed in Section V. We discuss related studies in Section 6 and provide a summary in Section VII.

II. Research Background

A. Inherent Problem in WBL

Today, on the Web, there is a wide variety of high quality learning content, such as OCW (OpenCourseWare) [3] and MOOCs (Massive Open Online Courses) [4], and WBL is developing at a frantic pace on a global scale. In fact, free online courses provided by famous MOOC platforms such as Coursera [5] and edX [6] are attended by several hundreds of thousands of people around the world.

These online courses are not only of the highest quality but the platforms are also constructed using cutting edge technology. For example, they have SNS (Social Networking Service) functionality and provide a venue for social learning, in which the students attending can learn from each other, and even in the final test for the online courses, the system attempts to take measures against illegal activities such as using stand-ins or impersonation, by analyzing the typing of the student.

However, even in such a cutting-edge MOOCs platform, the essential problem of "stagnation of learning activities brought about by ubiquitousness," inherent to WBL, is hardly considered at all. WBL is a highly convenient style of ubiquitous learning that enables learning "anytime, anywhere,

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by anyone," but this in turn often leads to stagnation. Learning activities without restrictions tend to be given lower priority and this lack of restrictions tends to mean that being able to study "anytime, anywhere" encourages the postponement of learning activities [7]. In fact, judging from the usage sate of the learning system in our department, we deduced that most students only accessed the learning content one week before the final exam.

B. Anti-ubiquitous Learning

The anti-ubiquitous learning espoused by us is a type of learning carried out by "specific people in a designated place at a designated time," created by ICT (Information and Communication Technology), and is based on a completely opposite concept to ubiquitousness. The foundations of this are also e-learning. In other words, anti-ubiquitous learning is not a face-to-face class in which e-learning is not used at all, but is learning achieved by adding restrictions and limitations to the ubiquitousness of e-learning.

Anti-ubiquitous learning, in which the student can study only at a designated time and place, creates a situation of "only being allowed to learn hear and now" which is created virtually using ICT. This increases the awareness and concentration of the student and promotes a more efficient and substantial learning experience. Furthermore, by making the student themselves specify this time and place for learning, the student physically assumes a learning attitude and learns regular study habits.

The important points related to anti-ubiquitous learning are the restrictions and limitations placed on the time and location of learning. This is because the time and location of learning are extremely important. In fact, in terms of the timeframe in which we can concentrate, there are individual differences based on lifestyle habits and natural biorhythms. However much you study during periods in which you cannot concentrate, you cannot expect this to be effective. The same thing can be said about the location, and there are individual differences in the places in which people can study. Based on this point, if we can pay close attention to the timeframe and place in which we study, we can expect even greater learning benefits.

However, there are technical issues such as specifying the location of learning, and this has made it difficult to completely realize anti-ubiquitous learning at the current time. However, if we suppose that there is a certain degree of correlation between the time and location of learning, it is possible to artificially simulate anti-ubiquitous learning, even for existing learning management systems. We implemented a simulated anti-ubiquitous learning using our existing learning management system WebClass [8], to verify its effectiveness [9]. More specifically, we carried out anti-ubiquitous learning and ubiquitous learning for two courses with the same content for two different students, and confirmed and observed its effects in terms of learning time and results. To state the conclusion in advance, we clarified that, in terms of both learning time and results, the student using simulated anti-ubiquitous learning produced better results.

Furthermore, we have also implemented a prototype of a system to support anti-ubiquitous learning. In concrete terms, this is a prototype system that enables and disables learning content according to a specified time and place for individual learners, based on the e-learning platform management system. This was a server system created on the Web, and it is necessary to create learning content based on original specifications from scratch. There is, thus, the critical problem that the huge amount of useful learning content existing on the Web cannot be used.

III. WBL Anti-ubiquitousness

A. Basic Approaches and Issues

In this study, based on the background to learning discussed in the previous section, we aim to establish a method to functionalize WBL anti-ubiquitousness. WBL anti-ubiquitousness is not difficult in principle. In concrete terms, restrictions on time and location are placed on access to learning content. This is achieved in the following steps.

- Specify a time and location in which the learning content can be accessed
- Control access to learning content based on time and location

In other words, it is possible to access at the specified time and from the specified location, but all other access is impossible. This kind of principle is extremely simple, but is completely different from normal access controls to Web content. That is to say, normal access controls on the Web are not based on time and location, but on IP address or host name. Additionally, this specification is performed at the server. There is the method of introducing a proxy server between the server and client but in order to cover a large number of unspecified users, a huge number of proxy servers are required. There are also methods of filtering IP packets, but this method cannot be said to be effective when the users on the client side have administrative privileges.

B. Essential Problem

In the case of WBL anti-ubiquitousness, there are more essential and technically difficult problems to resolve than that discussed in the previous section. These are comprised in the following two points.

- Concealing the learning content URL
- Preventing the learning content from being searched

Needless to say, if you know the learning content URL, the learning content can be can be accessed at any time from any location. However, due to the security issues of click jacking and phishing it is impossible for most browsers to conceal the URL.

Furthermore, in the present case of Google and other search engines, nearly all learning content can be searched using that search engine. It is possible to prevent the content from being searched, but this requires the cooperation of the side providing the content. However, with the numerous sites providing learning content, it is difficult to request the cooperation of all such sites or expect all of them to accept this request.

C. Change in Policy: From Compulsion to Self-Regulation

Based on the aforementioned points, we have changed our policy towards WBL anti-ubiquitouness. Until now, as access to learning content was controlled by the system, the policy for anti-ubiquitous learning was semi-compulsive. In other words, by making access to learning content impossible, a situation in which learning could not take place was created on the system, thus forcing anti-ubiquitous learning.

In contrast to this, in this study, by evaluating the learning conducted at a specific time and location, we increased the motivation for ubiquitous learning and adopted a policy in which the rules for time and location of learning were automatically protected. As long as this policy was followed, concealment of the URL related to learning content and search engine measures were all unnecessary.

This change in policy is not insignificant in terms of our research. However, our final objective is not to create a situation in which it is not possible to study. Rather, our objective is to have the students assume a proactive attitude toward learning and adopt regular study habits, thus creating a more effective and substantial learning experience. Considered from this perspective, our original direction has not changed.

Furthermore, this change in policy will lead to the resolution of issues that have been pending until now. With the policy until now, the student was unable to autonomously study using the learning content they discovered. Needless to say, if the student knows the URL, they can study at anytime and anywhere, which goes against the concept of anti-ubiquitous learning. This is the problem of antimony, and is also something with which we struggle. From the point of view of the student having a proactive attitude toward learning, it is desirable for the student to study content that they have discovered themselves.

In contrast, as the policy change on this occasion does not involve the URL of the learning content being concealed from the student, the student can proactively specify the learning content and proactively engage in anti-ubiquitous learning. We consider this to be extremely significant.

With this policy change, one might think that WBL anti-ubiquitousness itself has become redundant. However, whereas the new policy relies on the proactive approach of the students, this alone does not form regular study habits in the students. Even with proactive learning, if the study involves irregular study and a lack of concentration, it is unlikely to be effective. For this reason, WBL anti-ubiquitousness is still extremely significant.

IV. Practical Process and Observations

A. Practical Process

The following shows the kind of anti-ubiquitous learning process that is practiced after the policy change from the perspective of students and teaching staff (evaluator).

- Student:
  1) Selection of learning content: Look for content to study themselves.
  2) Specification of learning time and location: Specify learning time and location for learning content.
  3) Practice of learning: Access the learning content at the specified time and specified place and study.
  4) Retention of learning history: Keep learning history after completion of the learning.
  5) Request for learning evaluation: After the learning is complete, the learning history is sent to the teaching staff (evaluator) for evaluation.
- Teaching staff (evaluator)
  1) Acquiring the learning history: Receive the learning history sent by the student.
  2) Learning evaluation of the student: Evaluate the learning activities of the student based on the learning history sent by the student.

This envisages a situation where the teaching staff reflect the results of the learning evaluation in the results of the student.

B. Observation: Newly Requested Items

In this study, the evaluation of the learning history of the student by the teaching staff increases the motivation of the student and creates a function for WBL anti-ubiquitousness. The following is required for this.

- Retaining learning history.
- Prevention of the learning history being modified.

The point is the retention of the learning history. In other words, leaving learning history at the specified time and place. As learning history, it is reasonable to leave learning time, learning content, and learning location. It is not difficult to achieve this. Once the specified end time has passed or the specified location of study is left during the specified learning time, one could stop measuring the learning time.

This kind of learning history must not be something that can be easily modifiable by the student themselves. For this reason, it is desirable that the learning history be encrypted. Currently, the best option is to use public key encryption. This case is based on the assumption that the person evaluating the learning history holds the public key and the student knows the public key in advance. Execution efficiency tends to be an issue with public key encryption systems, but as the size of the learning history data covered by the encryption in this study is small, and it is not necessary to use such strong encryption, there are not so many operational problems.

V. Implementation

With the policy change in this study, the system supporting WBL anti-ubiquitousness was also newly re-designed and a prototype created.

A. Basic Implementation Policy

The basic policy for prototype implementation is as follows.

1) Do not change the learning content code
2) Do not require the user to have any special knowledge or technical ability
3) Do not require implementation of any special program
4) Do not rely on a specific Web browser

1) and 2) above can be considered preconditions rather than just policy. It should be noted that 1 above includes changing the configuration file of the web site providing the learning content. 3 above refers to a special program other than a web browser, but in some cases, a web browser plug-in

may also be required. Furthermore, 4 above should be implemented as much as possible and its complete implementation is considered to be difficult. Currently, support for HTML5 [10] and CSS3 [11] differs according to the web browser, and complete compatibility is considered to be impossible. In fact, our prototype assumes Firefox [12].

B. Functional Requirements

The functional requirements for a system to support WBL anti-ubiquitousness are as follows.

- Registration of learning content

1) Acquire and register learning time (start/stop)
2) Acquire and register learning location (positional information)

- Learning content access controls

Access controls for learning content according to learning time/location

- Retention of learning history

Retention of information on study time/content/location

- Preventing the alteration of learning history

Encryption and decryption of learning history

The functions described in 1 and 2 above are core elements in WBL anti-ubiquitousness, but as stated previously, this alone will not provide WBL anti-ubiquitousness functions. The main points are the functions in 3 and 4 above, and these hold the key to its realization.

C. Non-functional Requirements

When creating our prototype, we set the following non-functional requirements based on the knowledge obtained from our research up to this point.

- Should work as an individual program without requiring a server
- Database is not required to retain learning history

All of the prototypes we have created until now have been server-based systems. However, in this case, an operator is required to run the server system. We consider that, while it is possible to develop and distribute a server-based system, its support is difficult from an operation and maintenance viewpoint. In particular, if security problems occur, as this is affected by whether a full-time administrator is there and their level of technical ability, a system realized as a standalone program that can be used easily by end users is considered desirable.

Realizing the system as a stand-alone program also affects the method of storing data. In the case of a server system, it is usual for a database to be used to store the data. However, if the system is implemented as a standalone program for the end users, there is no need to use a database. This, in turn, lowers the hurdles faced in using this system. This is because a corresponding level of knowledge is required to implement and manage a database. Furthermore, when sending the learning history stored as data to the evaluator, it is desirable that the data storage format be simple and that special software is not required to view it.

D. Prototype System

Currently, we are implementing a prototype system that meets the functional and non-functional requirements described in the previous sections. In concrete terms, we are implementing the prototype system as a standalone program operating in a web browser (see Fig. 1). The details of this are as follows.

- Languages: HTML5, CSS3, JavaScript
- HTML5 API: Geolocation [13], Web Storage [14]
- CSS framework: Bootstrap [15]
- JavaScript libraries: Criptico.js [16], BigNumber.js [17]

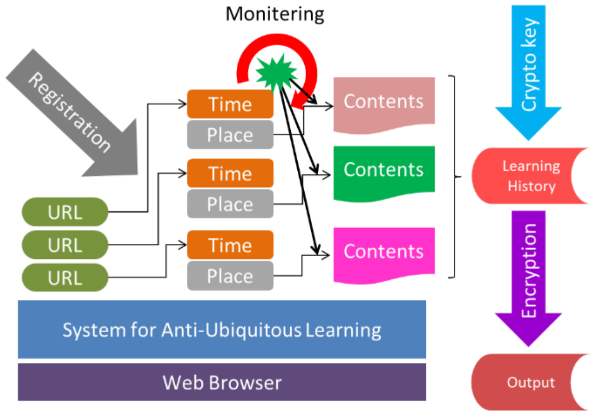

Fig. 1. Prototype architecture.

The learning location (positional information) is obtained using the Geolocation API in HTML5. As there are issues with the accuracy of positional information that can currently be obtained, a margin of error corresponding to the learning location shall be allowed. However, as this is not the essential problem of the study, there is no plan to use special sensors, and we have decided to wait for future technological innovations. As the longitude and latitude data for the Geolocation API is a small number with up to nine decimal places (floating point number), this is handled using the JavaScript library BigNumber.js.

The registration information for the learning content uses HTML5 Web Storage and this is stored on the local device. In concrete terms, the registration information is as follows.

- Name of the learning content
- URL of the learning content
- Learning time: start/stop time
- Learning location (position): longitude/latitude

HTML5 Web Storage is not a cache, but is a permanent data area, and is not deleted even when the web browser is closed. Whereas there are capacity restrictions, there is sufficient space to save 20-30 cases with the above level of information.

The learning history data is encrypted at the end of the learning and saved as a text file each time. As the learning history is sent to the guiding instructor for evaluation, this is the kind of specification that is required. For encryption, the JavaScript library Cryptico.js with a public key system (RSA encryption) is used. Cryptico.js can specify the length of the encryption key (number of digits) and supports a sufficiently strong level of encryption.

Furthermore, functions and a user interface for the learning history evaluator (teaching staff, etc.) are also implemented in the prototype system. In concrete terms, it provides a function for creating public keys for the evaluator and a function for decrypting the encrypted learning history sent by the student.

As described above, the prototype system is a program that operates in a standalone way created using only HTML5, CSS3, and JavaScript. Needless to say, the operation of the prototype system does not require a web server, and there is no need to deploy database software.

E. Correspondence between the Student and Evaluator

An image of this anti-ubiquitous WBL using this prototype system is demonstrated as a time series.

- Evaluator: Creates public key. The created key can be saved as a text file.
- Student:

1) Acquires the public key of the evaluator and set on the system
2) Decide the learning content
3) Decide the learning time/location:
   a) Learning time: start/end time
   b) Learning location: longitude/latitude

The learning location can be displayed on the map using the Google Map API and confirmed (Fig. 2).

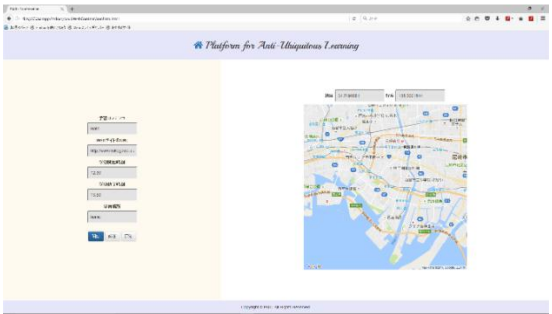

Fig. 2. A capture image of the prototype system.

1) Register the URL/time/location of the learning content
2) Implementation of the learning:
   a) When the registered learning content is accessed between the learning start time and end time, the learning content is opened as a new tab on the Web browser.
   b) The learning time is measured.
   c) A check on the learning time and location is conducted by the system in set periods.
   d) When the learning end time is reached, a beep sound is made and an alert dialog box is displayed, at which time the learning history save process takes place. The learning history is encrypted using the public key of the evaluator when saving and saved as a text file.
   e) Where the student leaves the learning location before the end time of the learning, the measurement of the learning time is stopped and this fact is displayed using an alert dialog box.
3) Transmission of the learning history: The learning history saved as an encrypted text file is sent to the evaluator using a method such as email.

- Evaluator: Receives the encrypted learning history, decrypts it and evaluates the learning activities of the student.

VI. Related Research

As it is considered that ridding restrictions on time and place for learning is the main merit of e-learning such as WBL, there is basically no concept of restricting this aspect. However, there are similar methods, such as self-regulated learning and CBL (Cohort Based Learning).

With self-regulated learning, the students themselves proactively set up their own learning plan and engage in learning. The result of this is a method in which the learning is self-evaluated [18]. This kind of self-regulating learning has gained attention in recent years as a method of increasing the benefits of e-learning. The fact that the learner themselves proactively draws up the plan is a common feature with anti-ubiquitous learning, but it is difficult for this alone to provide the necessary increase in tension, concentration, and awareness required for learning. Furthermore, with self-regulated learning there is no concept of learning location.

CBL is a method of group learning where the start and end of the learning course are clearly determined and the learning objectives and issues are requested to be cleared every fixed period [19]. CBL was adopted by Illinois University to increase the benefits of e-learning and has brought about good results. It shares with anti-ubiquitous learning the fact that it places time-based restrictions on e-learning, but with anti-ubiquitous learning, the student themselves proactively sets the time frame within which they can concentrate the most and this has a completely different meaning to time setting in CBL. There is also no concept of location in CBL.

The context-aware LMS (Learning Management System) of Kajita *et al.* is an education support system, in which the context of the teacher and student (terminal used/user environment/user format, etc.) is captured, integrated, and analyzed. The service content is then processed and presented based on this [20]. This can be said to be close to anti-ubiquitous learning but this is more easily positioned as ubiquitous learning that supports learning at a specific time and place [21]. Ogata et al. also performed the same kind of research [22], and rather than the ubiquitous learning and anti-ubiquitous learning competing, they are actually complementary.

There are also non-system based approaches to resolving the issue of stagnation in learning activities for e-learning. For example, there has also research on e-learning mentors [23] and on blended learning [24], which integrates e-learning and face-to-face learning. However, compared to WBL, which has an unspecified number of users, and MOOCS, which has been used by several tens of thousands of people, the introduction of mentors or realization of blended learning, while appropriate, may not be realistic.

VII. Summary and Future Plans

In this study, we propose a method of covering the technical issues in WBL anti-ubiquitousness through operation, and a support system for this. Through innovations on the operational side, it is possible to avoid problems such as web security that are difficult to resolve at the technical level. Furthermore, achieving anti-ubiquitous learning using the high quality learning content that exists on the Web is truly significant.

Moving forward, we plan to complete our implementation of the prototype system and perform verification tests, verifying the effectiveness of anti-ubiquitousness in WBL.

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