ABSTRACT
As the result of wide spread of self-exploratory, efficient, and user-friendly personal computers, the major interest of the ICT literacy has been shifting from how to use the computer and connect the network to how to create new value using them. One of the recent interests is the system and the pedagogy to support youngsters to learn how to collaborate on the Web and create the collective knowledge. When students participate in the construction of collective knowledge in class, drawing on contexts such as the real Web, they can develop information literacy that is not limited to operational skills such as using a computer, connecting to the Internet, and searching for information.

In this study, we developed the “multidatabase” module to enable ordinary teachers inexperienced in ICT to provide an effective information literacy class. Teachers can use this module in conjunction with study worksheets, which are widely used in school education.

We assessed the effectiveness of this module in a fifth grade elementary class, clarifying that, through the use of the “multidatabase,” (1) students can easily participate in the construction of collective knowledge and (2) students’ motivation increases, and results are also achieved in the specific subject area covered.

KEY WORDS
Information Literacy, collective knowledge, CMS, NetCommons.

1. Introduction
Since the use of the Web has spread widely in society, people are now required to learn the ability to convey information and communicate with others using written language. Sugawara(2013) [1] pointed out that we may have entered a period when activities that “create value,” such as proactively utilizing the Web and expanding social networks, strongly influence the quality of people’s daily lives and their realization of happiness. He defined information literacy as the ability to participate proactively in a Web society. He also pointed out that, for information literacy education to develop students’ literacy, step-by-step training beginning at the elementary school level is necessary.

For students to acquire such a new literacy, it is necessary for classes to change focus from a conventional, closed learning approach to one that is truly participatory in terms of value construction, such as the construction of collective knowledge on the Web. In addition, it is necessary for information literacy education to be addressed not only as a separate subject but also as part of many other subjects.

However, even if a teacher wants to follow this approach, it is difficult to provide the type of education described here because of the high cost necessary to install the system, build a database, and employ ICT support staff. Consequently, information literacy education is very difficult to achieve in ordinary elementary and secondary schools.

In Japan, NetCommons [2] is the most popular Contents Management System (CMS) for making elementary and secondary school homepages, and its usability in schooling has been described in previous works [3][4]. In this study, we developed the “multidatabase” module on NetCommons to enable teachers to conduct classes where students build a database for the construction of collective knowledge and publish this on the Web. Through experimentation, we demonstrate the effectiveness of the module.
2. Related studies

2.1 LMS and e-portfolio

At present, several information systems for education, including the Learning Management System (LMS), have been developed [5]. Blackboard [6] is the most popular proprietary LMS software in the world. The most popular open source LMS software is Moodle [7]. Moodle has been introduced in many elementary schools, secondary schools, and universities. Since it is an open source software and is easy to install, many researchers have pointed to its usability [8]. Sakai [9] has been developed as open source software that runs in the Java environment.

Recently, e-portfolios have been developed to enable students to document the learning history and publish evidence of this to showcase their achievements [10]). For example, Mahara [11] and Sakai OSP [9] were developed as open source softwares and used in schools.

Although several LMS and e-portfolios have been developed and disseminated, these systems have been developed with the idea of supporting the learning of individual student. Therefore, LMS and e-portfolios open source software for schools do not enable multiple students to participate in constructing content on the Web and building a database.

2.2 Worksheet learning and information dissemination through the web

In school education, the effectiveness of educational paper worksheets has been discussed extensively, and worksheets are widely used. To this point, various worksheets have been developed for each subject by many researchers and teachers. Based on the context where worksheet learning spread, the popularity of worksheet learning is probably driven by its (1) effectiveness in promoting the independent learning of students, (2) efficiency of production in terms of the teacher’s time, and (3) adaptability, ease of adding and changing the entries on a worksheet form even in the middle of a class.

Success of education in Japan depends especially on teachers’ engagement, including in the use of original worksheets and discussion using the worksheets. Formerly, elementary school teachers in Japan made original worksheets for their classes [12][13][14].

As worksheets are paper media, it is difficult to share written information, pasted photographs and pictures in the classroom, school, and the broader Web. In elementary and secondary schools, it is necessary to educate students about how to convey information and to guide students in a way that increases their motivation to participate in the Web. However, education using only worksheets does not satisfy these needs.

2.3 Participation in the Web using written language

Based on his analysis of building intelligence and knowledge since the advent of Web 2.0 applications such as Wikipedia, blogs, and social networking sites, Sugawara (2013)[1] pointed out that these activities have been dependent on CMS interfaces. Literacy of using language (“linguistic literacy”) is essential for participating in Web society, as represented by CMS, where communication is based on communication between strangers through asynchronous bi-directional media, written language, digital images, sound, and video. Sugawara further noted that it is necessary for students to acquire linguistic literacy that will enable them to convey information on the Web starting in the elementary and secondary stages of education.

3. Study purpose and hypothesis

3.1 Purpose

It is necessary for students to acquire information literacy in various subjects and units. Since worksheet learning has already been shown to be highly effective in reaching learning objectives in various subjects and units, it is desirable to use worksheets for information literacy education. For instance, while “recommending favorite books” or “learning about local culture and life,” students can easily create the construction of collective knowledge on the Web using the written contents of a worksheet created together with their teacher as part of education in various subjects and units, including information literacy education.

It is necessary to develop an information system to conduct such a class. Although several information systems have been developed for education, information systems that are open source software and meet teachers’ needs may not have been a part of this. Therefore, we developed the “multidatabase” module, which runs on CMS, for school websites. This module has functions that work together with paper worksheets for the construction of collective knowledge and support information literacy education for students to enhance participation in the Web society. Through putting this model into practice, we demonstrate the module's usability.

3.2 Hypotheses

In Japanese education, as teachers use original worksheets, we have developed a CMS module that can work together with worksheet learning. The module enables students in ordinary classes in general schools to create a database and participate in the Web society. We think that the “multidatabase” module not only supports making databases but also raises students’ motivation.

Therefore, our hypotheses in this study are that (1) by using a multidatabase module, it is possible to turn paper-based worksheet learning into the construction of
collective knowledge, and (2) as a result, students acquire information literacy. We developed the module and a trial lesson to test these hypotheses.

4. Implementation

4.1 Specification of the “multidatabase” module

In Japan, NetCommons is the most popular CMS for making elementary and secondary school websites. NetCommons was developed by the National Institute of Informatics (NII), Japan [15] beginning in 2005 and is distributed as an open source software. The prefecture boards of education play a central role in the uptake, NetCommons has been introduced into more than 3,500 schools.

Why is NetCommons used in schools? In the context of elementary and secondary schools in Japan, where NetCommons has spread, the reason for its popularity is not only the fact that it is open source software but also that the implementation of the following functions is suitable for use in schools.

- When installing NetCommons, modules for school education are installed together.
- The principal administers the whole system as “system manager” and can control the school website.
- The “system manager” can appoint a manager for system management separately.
- The “system manager” creates a closed group room for individual classes. The teacher of a class manages a group room as a “chief.” The “chief” is a group room manager.
- The “chiefs” manage and design group rooms.
- Students log on as “common users” and, with authorization, can create content and engage in activities.

To perform the suggested lesson, it was necessary to develop a database module that implemented the following functions.

- Comments on the content are not opened until the teacher permits.
- A database is constructed (collective knowledge) in the group room and can be easily published on the Web by the “system manager.”

The second author played a key role in developing the module with these functions. For implementing the function of pasting book cover images, we used the Amazon affiliate service to paste book cover images into the content without incurring copyright problems.

4.2 Implementation

We describe the specifications of the “multidatabase” module below.

The “chief” (teacher) can select metadata as specified in the following list (Table 1) and easily change settings by dragging and dropping them in the browser (Figure.1).

<table>
<thead>
<tr>
<th>Metadata</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text box</td>
<td>Text of one line</td>
</tr>
<tr>
<td>Text area</td>
<td>Text of plural lines</td>
</tr>
<tr>
<td>Link</td>
<td>Link with the A(src) tag</td>
</tr>
<tr>
<td>Selective type</td>
<td></td>
</tr>
<tr>
<td>Radio button</td>
<td>Single choice</td>
</tr>
<tr>
<td>Check box</td>
<td>Plural choice</td>
</tr>
<tr>
<td>WYSIWYG</td>
<td>HTML editor</td>
</tr>
<tr>
<td>File</td>
<td>upload a file</td>
</tr>
<tr>
<td>Picture</td>
<td>upload a picture file</td>
</tr>
<tr>
<td>Automatic number</td>
<td>registered automatically</td>
</tr>
<tr>
<td>Mail type</td>
<td>Link with the A(mail) tag</td>
</tr>
<tr>
<td>Date</td>
<td>The date and time</td>
</tr>
<tr>
<td>Registered</td>
<td>The registration date and time</td>
</tr>
<tr>
<td>Registered</td>
<td>(registered automatically)</td>
</tr>
<tr>
<td>Update</td>
<td>The update date and time</td>
</tr>
<tr>
<td>Registered</td>
<td>(registered automatically)</td>
</tr>
</tbody>
</table>

![Figure 1. Metadata edit mode](image)
The form of the worksheet may be changed as per the progress of the class. It is therefore a necessary function that the teacher can change the metadata later.

The module has 7 tables: multidatabase, multidatabase_metadata, multidatabase_metadata_content, multidatabase_content, multidatabase_comment, multidatabase_file, and multidatabase_block. Figure 2 displays the Entity–Relationship Diagram.

![Figure 2. Entity–Relationship Diagram](image)

5. Practical application

5.1 Subject: Japanese language (fifth grade elementary class)

In January 2012, trial lessons were conducted on the subject of Japanese language with fifth grade students at K Elementary School to assess the effectiveness of our newly developed module. In total, 58 fifth grade students participated in the lessons (A-class: 29, B-class: 29).

5.2 Lesson content

The lessons lasted five hours, during which students created around 100–150 characters of content, including an outline and his/her impression of a book that they wanted to recommend to a friend. A teacher designed the database using the module. The database constructed collective knowledge by gathering multiple students’ content. A book cover image was incorporated, and a user who was interested in the book could look at the contents. The five hours of the lessons were used in the following way.

In the first hour, the students makes a catchphrase, outline, and their impression of the book to be recommended. The teacher encouraged students to be strongly conscious that the content would be published on the real Web. The teacher also pointed out that people in the Web are of different ages and genders and have multiple perspectives, so content should be written such that it could be understood, regardless of who was reading it.

The teacher distributed a worksheet (Figure 3), and the children filled it out (as a draft version). Printed on the worksheet was a list of key points on the characteristics of a good sentence.

During the second and third hours for the lessons, the students improved their work in groups. The students read the worksheet of a peer and advised each other on improving the sentences. Students used the list of key points to improve their work. In this way, they completed the worksheets.

In the fourth and fifth lesson hours, the students uploaded their work on the CMS and completed and mutually evaluated the content.

5.3 Design of the worksheet and input form

In Japan, manuscript paper (“Genkoyoshi”) is used for composition education. Manuscript paper contains printed division lines, and students write one character per division. Students learn to write a sentence being aware of the number of characters to write. Despite the widespread use of personal computers, elementary and secondary school teachers use manuscript paper for teaching writing. Therefore, students are accustomed to writing on manuscript paper.

For these trial lessons, we designed a worksheet with printed division lines and set up the input form of the “multidatabase” with a design similar to the worksheet (Figures 3, 4).

![Figure 3. Worksheet](image)
To this point, databases of this kind were installed by an ICT engineer or a teacher who was an ICT expert. Now, however, it is possible for an elementary school teacher who is not an ICT expert to build a database easily using the module we developed. In addition, the module can reduce students’ recognition load in entering data, because a teacher can design the database input form to resemble the familiar worksheet input form.

6. Results and discussion

6.1 Questionnaire results

Before and after the trial lessons, 54 students responded to questionnaires. Our aim was to see the students’ motivation.

(1) Pre-lesson questionnaire

In the pre-lesson questionnaire, 83% of the students answered positively (“agree” or “somewhat agree”) when asked “Is there a book that you like?”; 72% of the students answered positively to “Would you like to recommend the book you have read to a friend?” From this question, it is clear that almost all students who participated in the study liked reading and wanted to recommend a book to a friend.

In contrast, 67% of the students responded negatively (“disagree” or “somewhat disagree”) to the statement “I like writing my impressions of reading or an essay about my daily life,” and 57% of students responded negatively to the statement “I want my friends to read my impressions of reading or essays about my daily lives.” More than half of the students had a negative perception of writing about impressions of reading and writing an essay of their daily lives.

(2) Post-lesson questionnaire

When completing the questionnaire after the lesson, 98% of the students responded positively to the statement “I want many people to read the content that I made.” Conducting a *t*-test revealed a statistically significant difference (*t*(53) = -10.627, *p* = .00 (< .05)), between the pre-lesson questionnaire item, “I want to read my impressions of reading or essays about my daily lives,” and the post-lesson questionnaire item, “I want many people to read the content that I made,” when considering students’ responses to these items as the dependent variable (agree = 4 points, disagree = 1 point). This finding indicates that students’ attitudes changed from negative to positive. They began with the negative idea that they did not want their friends to see their writing when completing the pre-lesson questionnaire.

As the reason for the significant change observed in the students over the course of the lesson, their self-confidence grew a great deal as a result of producing attractive content using CMS and working in groups to improve their sentences. When asked to respond to the statement “It is good to paste an image of a book cover into my content,” 96% of students responded positively, and 93% of students responded positively to the statement “Reviewing the content, there was a book I wanted to read.” (Figure 5) Thus, using the “multidatabase,” the students were pleased to have produced attractive and valuable content.

6.2 Content evaluation

In the next stage of the study, we analyzed the content presented to determine whether the sentences actually improved through group work. We evaluated the content produced by B-class (29 students), tracing changes between the draft worksheet completed in the first hour of the lesson and the completed content. For this, we used three methods: (1) content evaluation by the user, (2) criterion referenced evaluation, and (3) change of the writing style.

(1) Content evaluation by the user

We conducted a comparison evaluation of the content by the user through an experiment with a total of nine participants (six university students and three graduates). We gave the participants a list of key points used in the lesson for them to understand the characteristics of a good
sentence. The objects for evaluation were the draft version (textual data written on a worksheet, completed in the first hour) and the final version (student-created database content).

In this experiment, we asked participants “Which is the final version?” Participants were presented with a forced alternative type response, and they were asked to choose between two sentences. There were 29 pairs of sentences from the draft and final versions of the content that were randomly placed on the left or right.

The Wilcoxon signed-rank test, a non-parametric test, indicated a statistically significant result, as many of the sentences from the completed content were selected as good sentences based on the list of key points provided for the evaluation ($p = .00 (<.05), Z = -3.800$).

(2) Criterion referenced evaluation

We identified the types of common errors using a list of evaluation criteria (Table 2).

| 1. Using the wrong conjunction |
| 2. Using the prohibition words in the lesson. |
| 3. Subject–verb disagreement. |
| 4. Wrong use of the connective particle. |
| 5. Repetition of words |
| 6. Typographical errors |
| 7. Wrong use of the article. |
| 8. Wrong use of the adjective. |
| 9. Confused (We do not understand the phrase) |

After evaluating the content presented by the children using the evaluation criteria, we found that the most common type of error was “3. Subject–verb disagreement.” A typical example of this was, “The impression that I got from reading The Little Genie—genies are the spirits of the lamp that use magic, Ari—has become small.” In this example, we do not understand the sentence because the subject is “impression” and the verb is “become.”

Thus, when we evaluated the sentences written by the students, if we found subject–verb disagreement, we determined that the student had not yet reached the stage where he/she could judge the logical coherence of sentences. We defined these children as “pre-stage of subject–verb agreement” (“pre-stage”). In cases where we evaluated the sentences written a student and found that the subject corresponded to the verb in all sentences in the content, we determined that the student was in the “post-stage of subject–verb agreement” (“post-stage”).

We assessed the ratio of change from the “pre-stage” to the “post-stage.” Before the lessons, 20 students (69%) were “pre-stage” and nine students (31%) were “post-stage.” Approximately 70% of the students were not able to write sentences in which the verb agreed with the subject. Assessing the content created by the students following the lessons, five students (17%) were “pre-stage” and 24 students (83%) were “post-stage.” About 80% of the students were able to write sentences that exhibited subject–verb agreement (Table 3). A chi-square test revealed that the increase in “post-stage” students from 31% to 83% was statistically significant ($p = .00 (<.05), \chi^2 = 15.818$).

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Subject–verb agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre</td>
<td>20</td>
</tr>
<tr>
<td>Post</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
</tr>
</tbody>
</table>

(3) Change in writing style

In this lesson, we limited the number of characters of content a student could produce to 100–150. Therefore, it was desirable for each sentence to be expressed clearly and concisely through revision. We evaluated the change of the writing style between the draft and the final version of the student content. We found statistically significant reductions in the average number of characters used overall, characters used in each sentence, and commas. In addition, the number of periods significantly increased (Table 4).

These results indicated that students shortened the length of their content to improve it.

| Change of writing style (N = 29) (* = $p < .05$) |
|-------------------------------|-------------|-------------|
| Average | Pre | Post | $t$ value |
| number of characters of contents (SD) | 138.10 (25.31) | 128.34 (16.17) | .033* |
| number of characters in one sentence (SD) | 36.05 (7.87) | 31.42 (6.58) | .004* |
| punctuation mark interval (SD) | 13.55 (5.00) | 14.45 (3.68) | .303 |
| number of commas (SD) | 6.48 (3.60) | 4.48 (1.72) | .004* |
| number of periods (SD) | 3.93 (0.75) | 4.24 (0.91) | .048* |

These three types of analysis indicate that, as a result of the lesson, students’ written sentences improved.

6.3 Qualitative analysis

In the post-lesson questionnaire, 98% of the students responded positively to the statement “I want many people to read the content that I created.” This indicates that almost all the students wanted others to view the content that they created. Following the lesson, the students were given a free writing survey to explore what
the students thought about the lesson. Using this survey, we examined what the students thought about the lessons in which they had just participated.

Our method for analyzing the surveys was to sort the topics about which the students wrote and then consolidate their content into categories. The analysis of the free writing survey (with 55 valid responses) revealed that the largest percentage of students (58%, 32 students), indicated that they wanted people around the world to view their content.” Students wrote, for example, “I am happy because I show my favorite book to my friend and my content is seen by the world.” Students wished that many people would see their content, and for that reason they revised and improved their content.

When we reviewed the fixed-point video at the end of the third lesson, we found that, when the teacher said “In the next lesson, we will use the computer room,” some of the children exclaimed “Oh!” and one child clapped hands. This result illustrates the point that students also want to convey their content.

7. Conclusion

Since we developed the “multidatabase” module, teachers are able to conduct lessons where students participate in the construction of collective knowledge and produce Web content using their worksheets. By using CMS, this content is unified in design and attractive. Furthermore, the module has category search and keyword search functions. This contributed to the students realizing that they were participating in creating a database similar to other content on the Web, and they were consequently pleased.

In the free writing survey, 32 students (58%) noted that they wanted “people around the world to view their content.” Using the module, students could easily convey information in ways that could not be achieved through conventional worksheet learning, and this led to a high level of motivation. A great majority of students (91%) responded positively to the statement “My content is helpful for a person looking for a book to read.” In other words, more than 90% of the students thought that the database was valuable and that they had participated in the value construction.

Furthermore, by improving the wording of their sentences, it is thought that the students were able to achieve the original purpose of the lesson, i.e., to improve in the subject of Japanese language, since students significantly shifted toward “post-stage,” and the user evaluation also identified the improvements.

This study has shown the newly developed module to be effective in raising the learning motivation of students, because it not only involves creating a database from paper worksheets but also allows students to add to the collective knowledge of the real Web. These results support the hypotheses that, by using the “multidatabase” module, it is possible to adapt paper-based worksheet learning allowing the construction of collective knowledge, and, as a result, students acquire information literacy.

Since NetCommons has been introduced in many Japanese elementary and secondary schools, it will be possible for us to repeat this practical application for enabling students to build collective knowledge on the Web in the future. The next challenge is to develop a learning program that allows worksheets to be linked to multidatabase in various classes.

In addition, many digital worksheets for science and mathematics classes have been developed in Japan, but input forms and designs are fixed in many cases, and teachers cannot add anything to such input forms or change digital worksheet designs. However, teachers can easily design digital worksheets as they like if they use the module that we have developed. Thus we believe that it is possible to effectively utilize the module in various classes, including mathematics, science, and language, among others.

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