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## The improvement of an e-learning system for library classification based on the analysis of incorrect answers given by students

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### Abstract:

*The purpose of the study described here is to develop an e-learning system called NDC-trainer to be used for library classification training. This system gives LIS students the ability to practice creating proper book classification numbers by considering a wide range of information, including content descriptions or book outlines available on the web. With this approach, students respond to various questions stored in the system. These questions are displayed using bibliographic data from the National Diet Library Database. If the classification number created by a student is incorrect, the system gives an immediate indicator and displays comments based on patterns in the student's errors. In this paper, we describe the exercise of constructing a classification number by combining the class number for a topic with an entry from the auxiliary tables of NDC. A group of twenty junior and senior students in the Library and Information Science Program used the NDC-trainer for practice and responded to 31 questions. According to their comments, the system is usable and even enjoyable. Three distinctive features—having a large number of sample books, displaying links and rich content, and showing references immediately—are especially acclaimed. They also pointed out weaknesses in the current system and provide a roadmap for continuing improvements.*

**Keywords:** LIS education, classification, e-learning, NDC(Nippon Decimal Classification), subject analysis, library; Japan, training

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## **Introduction**

Library users often search for library materials by subject. One of the primary responsibilities of the librarian is to create a retrieval system that the user can easily use. Library classification can offer the most promising method for item retrieval, because the classification system points to a bookshelf where books are located based on the subject matter. This enables the user to find not only the retrieved book but also nearby books on the same subject. Thus, the library classification table is an essential tool for making the subject search by users more efficient.

By law in Japan, Information Organization is one of the obligatory subjects of the librarianship program (LIS program). It includes cataloguing, subject headings, and, most importantly, understanding library classification (Nippon Decimal Classification, or NDC). To develop the necessary level of understanding requires extensive practice on the part of LIS students. Given that library school students must do many exercises and teachers should try to maximize their understanding with assignments during limited class hours, a new e-learning system would be extremely helpful.

NDC is a proprietary library classification system in Japan. According to current statistics, 99% of public libraries and 92% of academic libraries use it[1]. Like Dewey Decimal Classification (DDC), NDC is an enumerative system that allows classifiers to construct a classification number by combining a number for a topic with a more specific entry developed from six tables, called auxiliary tables. The auxiliary tables cover commonly used elements such as geographical aspects, language and bibliographic forms. For example, a classification number could be constructed using 314 for parliaments + .71 for Australia to create the classification number 314.71 Australian parliament.

Noguchi critically reviewed NDC 9th edition, identifying areas for improvement [2]. Wada analyzed the structure of the relative index of NDC [3]. Ueda and Murakami developed the retrieval system for NDC [4][5].

A classification training system, NDC-trainer Ver1.0, was developed in 2014 [6]. This system was designed to teach students how to construct a classification number using NDC, combining the class number for a topic with an entry from the auxiliary tables. However, NDC-trainer Ver.1.0 can be utilized only for exercises involving divisions of NDC, but not the subject of the book. To date, there has been no system that uses practice e-learning tools to teach NDC.

## **Design of the system**

In the classroom, students practice subject analysis and the use of NDC to create proper classifications by responding to questions in which only bibliographies and short annotations of sample books are given, occasionally with a title page added. A better approach would allow students to work with more information such as a table of contents or a summary of the book from network resources. Moreover, students need repeated practice to attain fluency and confidence in the system.

When students practice subject analysis and NDC classification, common errors can be identified in classification number construction. If we total the mistakes in practice—not only

from our program but other schools as well — we can create an error database to help students practice more effectively and efficiently.

The purpose of this study is to develop an e-learning system for students to practice constructing classification numbers with NDC, and then to evaluate its implementation. The special functions of the software are as follows:

(1) To record the responses of each student and be able to provide appropriate questions commensurate with that student's skill.

(2) To analyze recorded responses for common errors and to add teacher instructions as needed. We apply two methods to analyze records: a method using a Japanese word-classification lexicon and thesaurus, and an experimental method using a sample having a pattern of student responses.

(3) To show analyzed results and teacher instructions relating to the corresponding errors.

(4) To display a detailed description of the classification rules and lesson video relating to the classification numbers.

(5) To gather sufficient sample book data for the exercises.

(6) To use online resources to set exercises.

(7) To use bibliographical records of current published books as samples.

These functions will be useful for a student to learn how to assign a classification number to books. In particular, functions (1) through (4) are useful to analyze the subject of the book, and functions (5) through (7) are useful to combine a number of a topic with an entry from a separate table of subdivisions of NDC.

## **Overview of the system**

The improved training system, which we call NDC-trainer Ver.2.0, enables students to view an actual published book, promptly judge whether their responses to questions are correct, and ascertain their mistakes. Importantly, students can select the next question based on their level of understanding of their mistakes.

It is possible for students to correct input items of various elements and create multiple classification numbers before clicking the judge button. They can also refer to their logs for exercise with the same type of question. After they receive a correct answer, they will then move to the next question, which the system can display automatically in accordance with the student logs.

NDC-trainer Ver.2.0 consists of the Harvester and Database Management Program module (Harvester Program Module) and Interface Program module. The Harvester Program module acquires sample book data from The Japanese National Bibliography, using the “NDL Search (Search service of National Diet Library in Japan)” system through a web interface (Web

API). We developed exercise questions from the results retrieved in NDL Search by classification numbers. The Interface Program module is designed for student practice.

Through the window of NDC-trainer Ver.2.0, the student not only can see the bibliographic record and view from the Amazon web site, but also follow the provided link to receive the content of the book, the author's personal history, and occasionally a book review as well. When students input a classification number, the entry words in NDC corresponding to the input classification number is shown in the display of NDC-trainer Ver.2.0. We wrote the Harvester Program module using Ruby/Perl/MySQL and Interface Program module using JavaScript. Figure 1 shows the software configuration of NDC-trainer Ver.2.0.

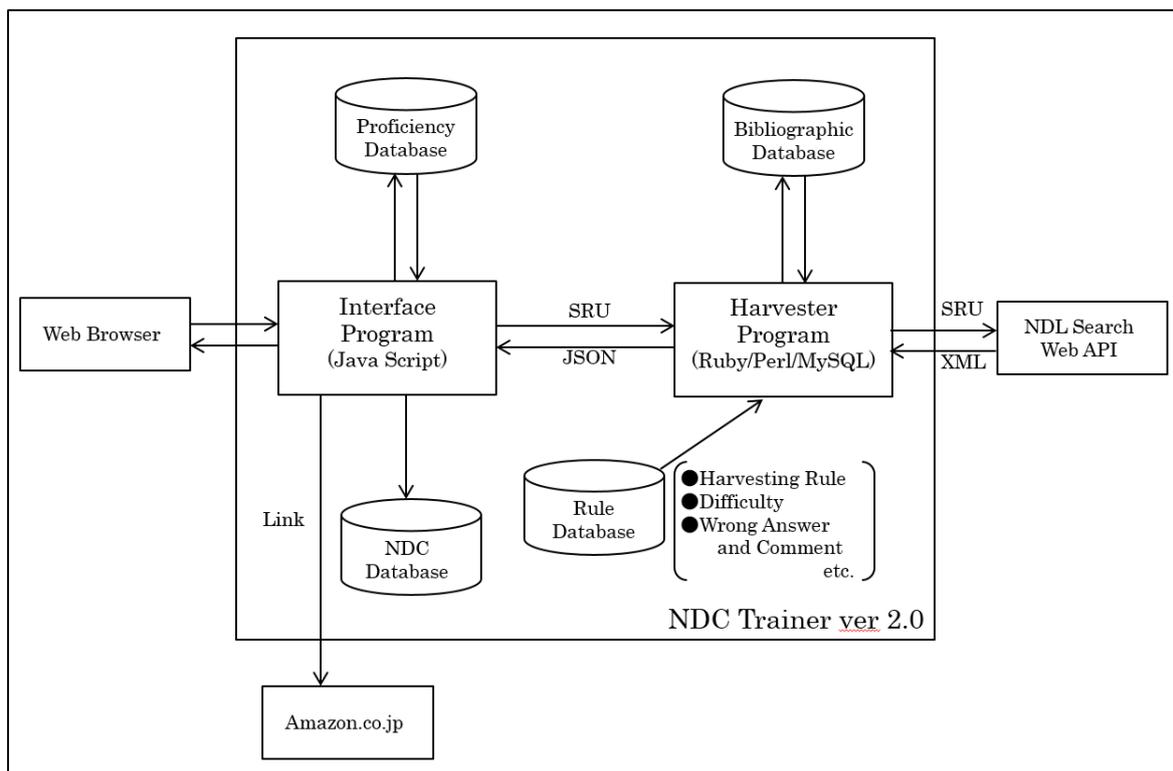


Figure.1 Software of configuration of NDC-trainer v.2.0

### Harvester and Database Management Program module (Harvester Program Module)

The Harvester Program Module is used for managing databases, harvesting book data from NDL Search, and providing question data. This module has two databases: the rule database and the bibliographic database. The rule database includes the harvesting rule, section number, difficulty, wrong answer data and comments.

From our experience teaching classification classes, we have found many cases in which students have difficulty assigning the proper classification number. For example, "The history of America and China diplomacy" has a very complicated classification number: 319.53022. This is constructed using 319 for Diplomacy (subject), 53 for United States (geographical division), 22 for China (geographical division) and 0 (the connector of two geographical divisions). Many students assign incorrect numbers. For example, they might use 319.5022 (too broad a geographical division: 5 is for North America), or 319.5322 (missing connector), or 319.5302202 (too much information: 02 is for history in the form division), or 678.253022

(wrong subject number: 678.2 is for trade). These kinds of classification numbers can be used to compose the rule for harvesting question collections from the national book database.

There are also many complicated topics and themes. For example, the classification number for domestic cattle is related to several different classification numbers: 648.25 for beef (meat), 645.3 for cattle as a labor source, 788.4 for bullfighting, 489.85 for bovidae, and so on. Many students have difficulty deciding which one is the most suitable subject for "cattle". These themes or topics are also good candidates for the rule for harvesting.

In the rule database, we can be define harvesting rules by using classification number, keywords in the title, or a combination of keywords and classification number. These rules can include regular expressions. For example, "ndc=319.53022", "title=cattle", "ndc=788.4 and title=cattle", "ndc=319.5[1-3]0[22|23|24]" and "title=cattle|cow". Using regular expressions is effective for similar topics.

The rule database also records section number, difficulty of question, wrong answer data, the number of errors by all students, and corresponding comments related to each harvesting rule. For instance, these data are stored in the database for the classification number 319.53022:

```
rule : "ndc=319.53022"
subject : "319"
geographical : "53022"
difficulty: 54           // the ratio of correct answer (*100)
section : "A12"         // excersize section number
correct_data: 113       // the number of correct answers by all students
wrong_data[1,0]: "319.5022" // wrong data[1]
wrong_data[1,1]: 24     // the number of wrong answer for [1] by all students
wrong_data[1,2]: "Too broader concept in geographical division....."
                        // comments for wrong data[1]
wrong_data[1,3]: "http://www.slis.doshisha.ac.jp/ndc/video1.mpeg"
                        // instruction video URL for wrong data[1]
wrong_data[2,0]: "319.5322" // wrong data[2]
wrong_data[2,1]: 11       // the number of wrong answers for [2] by all students
wrong_data[2,2]: "Missing connector. ...."
                        // comments for wrong data[2]
wrong_data[2,3]: "NA"    // no instruction video
```

The difficulty of the questions can be measured by storing the results of answers for each question. A good question does not simply mean that many students tend to answer incorrectly, but rather that there is a range between the number of correct answers and the variation of the errors.

Students answer in various patterns in their exercises. Some classification numbers are easily constructed, while other constructions are difficult for all students. Furthermore, students may have a favorite division from which to select. Researchers have found that very difficult exercises and extremely easy ones both decrease learning motivation [8]. In this regard, we implemented a new sample book based on student responses to a number of questions whose evaluation had already been established. Much relevant data can be stored as students try additional questions, making it possible to identify and accumulate more good questions.

The Harvester Program Module acquires corresponding book data based on the rule from the Japanese National Bibliography, using the NDL Search (Search service of the National Diet Library in Japan) system [7] through interface (API), and stores these book data in the book database. For example, there are 64 books with NDC 678.21053 classification.

## Interface Program module

Figure 2 shows the main window of NDC-trainer Ver.2.0. The upper section of the window gives a view of the book linked to the Amazon website, along with bibliographic data from the NDL Search system. In actuality, students can not only see the bibliographic record and view on the Amazon site; they can also use the link to receive the content of the book, the author's personal history, and occasionally a book review.



FIGURE 2. The main window of NDC-trainer Ver.2.0

In the center section of the screen are the input boxes in which students enter the subject and NDC numbers for the book. The “judge” button appears on the right. In this section, students input the subject number and division numbers separately. When a number is input, corresponding text is displayed. As each digit of an item is input, its meaning is shown in the

display. From this, students learn how to combine each element while confirming it. When the student clicks the “judge” button, the system determines whether the entry is correct or incorrect by comparing the input values to the correct classification number provided by the Harvester Program Module. Instruction comments are then displayed.

Because NDC is not open data, the function in the subject box supports only three digits. When students input more than three digits, the system displays the message, "Please show NDC book." Currently, a joint study project is being held by the Japan Library Association (JLA) and the National Diet Library (NDL), with a plan to make NDC linked data [9][10]. Although they have not yet determined whether NDC linked data will open as LOD(linked open data), NDC LOD is one of the themes in the project[10]. When the plan is implemented, our system will support four or more digits.

To begin a training exercise, the student selects a question category—simple subject, complicated subject, form division, geographical division, and so on. The Interface Module requests data from the Harvester Program Module using SRU protocol and receives book data, wrong answer data, and comments by JSON. When the student clicks the “judge” button, the system determines whether the input value is correct by comparing the value with the correct classification number provided by the Harvester Program Module. The module indicates correct/incorrect and displays relevant comments in the results area.

The system can record exercise transaction logs, so that the log files of all the students can be stored for the various questions. This means that student skills can be measured according to the theme of the questions.

## User Reviews

An analysis of error patterns was conducted using previous class exercises for developing NDC classification numbers. We collected 4885 data from the complicated homework of 158 students in our classes over a period of two months. A smaller group of students took the NDC-trainer Ver.2.0 test course and evaluated it. This group was composed of 20 junior and senior students in the Library and Information Science Program. They responded to 31 questions. Their comments were mostly favorable. The most commonly occurring errors and the corresponding error rates found in the previous class exercises and in the work of the users of NDC trainer Ver. 2.0 were shown in Table 1. As shown in the following table, nearly all error rates has been reduced. Especially, errors (3),(6) and (8) are improved significantly.

Table.1 The most commonly occurring errors

	previous class (of 4885 answers by 158 students)	users of the system (of 618 answers by 20 students)
(1) Poor understanding of the subject concepts, especially overgeneralizing the concepts	172(3.5%)	17(2.7%)
(2) Choice of the wrong subject aspect; for example designating domestic cattle as "labor power" and "meat"	75(1.5%)	10(1.6%)
(3) Selection of the wrong subject if the sample book has multiple themes	179(3.7%)	12(1.9%)
(4) Other wrong number input for the subject of the sample book	79(1.6%)	11(1.8%)

(5) Confusion of an item from the auxiliary tables and the topic number from the main table (subject)	181(3.7%)	21(2.9%)
(6) Item input from the wrong division	275(5.6%)	12(1.9%)
(7) Combination of errors	582(11.9%)	64(10.3%)
(8) Lack of understanding of form division	174(3.6%)	12(1.9%)
(9) Other errors	34(0.7%)	4(0.6%)

The link to Amazon and the display of new elements from NDL-Search serve as countermeasures for errors (1), (2), and (3). These features received a very favorable review from students. For example, many students commented that, "I understood well the subject of the book by viewing the book and finding content on the Amazon site."

Of course, there are some books that are not available on Amazon or have no ISBN, which means that these books cannot be used as exercise data in the current system. In addition, the quality of book data on Amazon and in NDL is varied. Given these limitations, the ability to include book-related information from other sources would be a useful system addition.

The reference feature, displaying corresponding text with the input number, serves as a countermeasure for errors (4), (5), and (6), and was well-received by the students. For example, students commented that, "The display for the subject and division numbers with the classification number and the meaning is clear," and, "I easily understood the interface by displaying each division number input area in every column." Though many students commented favorably, they also pointed out that allowing only three supported digits is insufficient. Moreover, some had a high opinion of the division reference area, while others did not.

There were some points for improvement recommended by the students who worked with the system. For example, one student commented that, "Only the last correct/ incorrect indicator is displayed; a user who wants to review should be able to press a browse history button." Another said, "When the next question is displayed, the correct/ incorrect indicator should be reset."

## Conclusion

We developed NDC Trainer Ver.2.0 so that students could practice creating library classification numbers for library materials in a supportive learning environment. According to user reviews, the system is usable and even enjoyable. Three distinctive features—having a large number of sample books, displaying links and rich content, and showing references immediately—are especially acclaimed.

NDC trainer Ver.2.0 can produce a number of different questions related to published books from the NDL book database. Using actual published books is an attractive feature for students. Unlike conventional text book approaches, our system relates to practical library operations. Moreover, with our system, students can study various aspects of classification for related topics.

NDC-trainer Ver.2.0 offers students much more information to create classification numbers in NDC than conventional exercise question sheets. The web link is a unique feature. Even in class, nearly all students will click the "link to Amazon" button and read many of the available elements, e.g., synopsis, outline, contents, and user reviews.

Many students pointed out that displaying the corresponding text with the number entered into each input box is the system's most usable feature. On the other hand, some students commented that they would like to use not only this feature, but also the NDC (paper) book. They preferred to use both sources of information, arguing that the corresponding text provided in the trainer is effective in refining the classification number, while the book is useful for comparing many candidates.

The system has other desirable features, including quick response and automatic selection of questions based on the student's skill level. Although students in our test group did not comment specifically on these features, such features enhance NDC-trainer's role as a practical tool and an important step forward in the education of future librarians.

We will continue developing NDC-trainer, improving it as appropriate. We plan to increase the elements and information in the main window and enhance the reference function. In addition, we will address the issue of inputting four or more digits into the subject box.

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