# Proposal of Database Design for Construction of Service for Skill Learning

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**Abstract**

In this paper, we propose the database design for skill learning service through the internet from the viewpoint of service engineering. This paper we describe the outlines for a design theory for skill learning service, which can lead to the satisfaction of both learner and instructor. Compared to other services, motion control learning takes a considerable amount of time, and this leads to a difficulty for learners to rate the quality of the service as well as for the instructors to provide consistent quality and standard of teaching. To solve these problems, we use a relational database with MongoDB which is an unstructured database allowing to flexibly incorporate the demands of both learner and instructor into the database itself.

## 1. Introduce

This paper proposes a design theory of a database for skill learning service and describes its features. The goals of our database are to discuss skills learning services about body movements and skills, to improve learning efficiency and to improve the satisfaction of both learners (service consumers) and instructors (service providers).

Because skill learning requires iterative learning to acquire cognition that combines physical exercise and knowledge [1], there are several problems, such as discrepancies between perception and behavior and tacit understanding of instructors [2]. Furthermore, in the current skill learning services, there is no opportunity of improving learning services by co-creating with the instructor and the learner because one-way teaching from the instructor to the learner was mostly adopted [3].

In this paper, to overcome those problems, we hypothesized a way of designing the database for skill learning and developed a prototype. We thought it is essential to plan specifications of our database so to flexibly incorporate the demands of both parties into the database to obtain a co-creation process between the instructor and the learner.

What is particularly problematic in skill learning is the learning of physical exercises and movements. For this reason, Chapter 2 describes the issues and problems related to motor control learning, and along with that, we define the requirements necessary for the database suitable for skill learning. Chapter 3 describes the database design theory behind the design of our database. In chapter 4, we describe experiments and results using sports skills learning as a context of the application. Chapter 5 serves as a conclusion and summary.

## 2. Features and Problems of Motor Control Learning

As a feature of motor control learning, iteration and repetition are necessary to obtain good synergy between body motion and cognition and to set a goal according to the movement skill level. The reason for this is that, due to several potential problems to be described later, it takes a somewhat extended period until the exercise is acquired, and in the meanwhile, the will to learn often decreases.

Compared to other services, motion control learning takes a considerable amount of time, and this leads to a difficulty for learners to rate the quality of the service as well as for the instructors to provide consistent quality and standard of teaching. In the case of learning services, it is known that when this negative psychology arises, taking measures to maintain learning continuity will lead to a sustainable level of service quality.

One of the problematic points of motor learning is related to anatomical features. It is because there are about 200 bones and approximately 400 skeletal muscles, and the size of the bones and the range of motion of the joints are different for each person, it can be considered that a perfect copy of the model of action is just not possible [4]. Furthermore, since the somatosensory system based on the sensory organ is different from person to person, even if we perceive that we are doing right movements, there might be errors in recognition of our many skeletal muscles, thus leading to mistakes in our changes. For this reason, inconsistency arises between cognition seeking to operate by rational understanding and actual body motion. We refer to this as a discrepancy problem of learner's perceptions and practical actions.

The existing research tackling those issues is extensive [5-8]. As far as we have investigated, those prior researches have not discussed a methodology to resolve the inconsistency actively. In other words, the cognition of these researches is limited to the knowledge about how to move the body, and the perception is represented by the verbalization of a vague image provided by the instructors. In our research, our experiments are based on time series analysis because, at the same time as the presentation is shown, we experiment inconsistency.

To solve the problem described above, we focused on the design and creation of a database. We looked carefully into the learners' behavior to tackle the mismatch between the learners' cognition and their actions. We also thought that it was inputting the data in the database would essential to record how the instructors conducted their lessons verbally and allowed them to review and check back the recordings.

Especially in skill learning, since the instructors


① Extracting data from Kinect ② Extracting various video data ③ Constructing the e-Learning system based on web

(Figure 1) Outline of I / O of developed database


(Figure 2) A part of web page of skill learning database

themselves rely significantly on their tacit knowledge, their instructing method is often not structured. Therefore, the specification (attributes in a table and database tables) of the database usually cannot be determined precisely in advance. For this reason, it is necessary to introduce a database design theory that allows the database to change inputs and expressions according to the instructor flexibly.

## 3. Construction of the database for skill learning

The database to be developed responds to various requests of the users (instructors and learners), it flexibly deals with the contents of services to be provided, with the requirements of the users and the ones of the environment where it is used. The database is also thought in such a way that the users can efficiently operate it. Then, by displaying the results of the data analysis in an easy-to-understand manner, the system can make use of the analyzed data to enable a more efficient response for the learner.

Firstly, we assumed that the instructor and the learner are located remotely. In addition, to provide versatility, we made it possible to see the database output through any mobile terminal with access to the Internet. It is assumed that the database is to be used in a so-called multi-platform. For this reason, input and output to and from the database were accessible through a web browser. This implies that we have adopted dynamic web technologies such as HTML 5, CSS 3 and jQuery to enable bidirectional data access with users.

To flexibly deal with the data provided by users, we built the database using MongoDB system that is a NoSQL technology. By using the non-structured database like MongoDB, each users' different data can efficiently process [9-10].

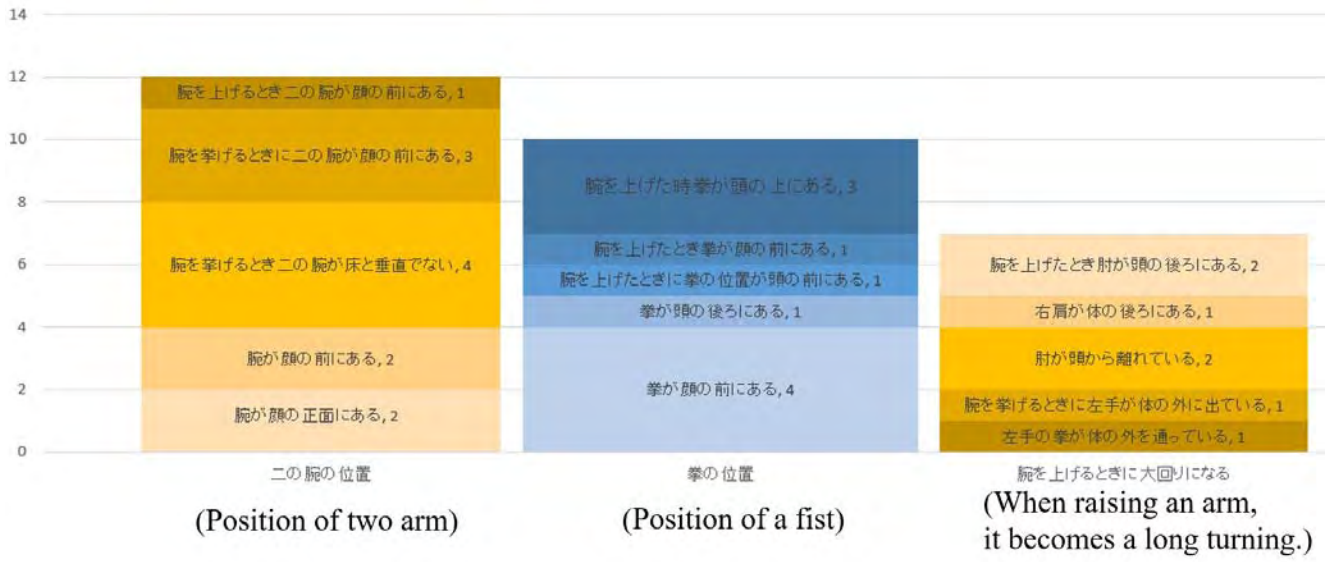
Our database is necessary to achieve a web-based learning system, to allow comments from users, and to collect data tracking the user's learning process to analyze their learning patterns. In addition, the database is designed to be able to manage video and picture data and other files and comments uploaded by the users themselves.

The system to be constructed is mainly aimed at the provision of courses using videos and images/comments, but the actual database design included the following functions (Figure 1).

1) The possibility of using various data other than video (voice, document, photo, file).
2) The possibility of different types of lectures and configurations (items) as required by content creators.
3) Collecting data generated through its use, such as feedback from users.

The web-based prototype of the operating system has made it possible to dynamically respond to user's request by using technologies such as HTML 5, CSS 3, jQuery.

Figure 2 shows the web page of the developed skill




(Figure 3) Comments appearing in feedback

database.

The image of the learning video is displayed first (①). The frame of the video related to the comment is shown, multiple comments can be added to the comment part below (③). This comment is synchronized with the time data of the scene in the video, and the data are stored in a database (②). Comments added by instructors and learners are stored in association with the video data (④).

It is necessary to design a system (database) with extensibility and flexibility because the items (attributes) may differ according to the learning contents. For example, the text input of the comment, the comment about the video frame, and the instruction by the voice. The website that is constructed reflects such a request, and the composition of the items of each comment is made flexible by using the HTML 5 and MongoDB.

## 4. Experiment

As a skill learning activity, we targeted Karate's upper block (upper defense). The training period took about a month, with four classes per week. The training process was carried out as follows.

- 1st training:

This session consisted mainly of a one-way explanation from the instructor to the learner for about 30 minutes. This training was aimed at explaining the posture and the meanings and methods of motion.

- 2nd training to 4th training:

These training consisted of recording the learner's movements through video and 3D skeleton models in our database. If an instructor were available, instructors and learners would look at the database record, stop recording and play the critical parts and point at the mistakes with verbal explanations and demonstrating gestures. In the absence of an instructor at the moment of the training, the instructor would watch the database later, input his or her indications and comments in the database, and later input feedback for the learners to look at so to train themselves according to the instructors' orders.

This training process lasted about one month, during which learners' self-learning videos and skeleton model 3D data, with the relative instructors' comments and questions of learners were collected.

We observed that the instructors were more likely to share objective assessment thanks to the possibility of using analytical data from the videos and skeleton models and by having time to think. The learner became more conscious about their mistakes thanks to the objective evaluation of the instructor based on the skeleton model. This represented a great improvement compared to the ambiguous words and the subjective assessment of the conventional learning process. Next, the result of grouping the comments collected by the instructor is shown in Figure 3. Looking at this result, it is possible to observe that there are many instructions related to the "arm," and from this, it can be said that the beginners' wrong movements mainly occur when moving up their arm for the upper defense.

## 5. Conclusion

The method proposed in this paper showed that it is possible to design a system that allows accepting the changes and request expressed by instructors, learners and other actors involved in the skill learning services.

As an example of database usage, about one month of skill learning was carried out for beginners, focusing on the "Karate's upper block."

We think that the number of learning samples was not enough in this experiment to come to definitive conclusions. However, we have observed that the instructors would benefit from, receiving a proper evaluation to store in the database, visualization of data, and examples of reference cases. Similarly, the learners would benefit from having a decent assessment based on objective comments and numerical values, and examples of other learners facing the

same problems. Therefore, it can be concluded that the designed database led to an enhancement of the skill learning process for both instructors and learners.

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