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Training-Course Design for General Purpose of Motor-Skill Learners on a Web

KenjiMATSUURA[a*], Hirofumi INUI[b], KazuhideKANENISHI[c]&HirokiMORIGUCHI[d]
[a]*Center for Administration of IT, The University of Tokushima, Japan*
[b]*Graduate School of Advanced Technology and Science, The University of Tokushima, Japan*
[c]*Center for University Extension, The University of Tokushima, Japan*
[d]*Institute of Health Biosciences, The University of Tokushima, Japan*
*ma2@tokushima-u.ac.jp

Abstract: In this paper, we describe the new proposal whose objective is to presentan online environment for physical skill learning. Our target skill is not only an intellectual one but also gross motor-skills such as rope-skipping and running. We developeda courseware system that covers wide areas of such skills because itsgeneral framework is based on the common taxonomy about the physical skills. With the supporting scenario, the system navigates learners to an appropriate direction from the novice task to the expert one.

Keywords: Motor skill, web system, Gentile taxonomy, navigation

1. Introduction

Most of human abilities in intellectual domains are not innate and both of quantity and quality of themalways grow up by way of specific efforts such as drill-practice in mathematics. When we deal with “skill” in an academic context, it is regarded as a posteriori ability whose mechanism and its learning process are much complex. Further, physical skills or motor-skills also require periodicpractices of repeating actions as well (Jarus, 1994).

There are several studies that deal with a skill-development with the objectives for sustainable training rather than spontaneous motivation of improving human’s ability.Being similar to them, motor-skill development is regarded in both academic fields and practical situations where many contexts arise depending on both individuals and environments. Therefore, a general taxonomy for common use is required as a principle.

By the way, skill science has a long history as an academic interdisciplinary field where it is related to other fields such as learning science and cognitive science (Schmidt, 1975). A lot of major theories are derived from it and othersincorporated to this fieldmutually.In concrete, “Schema-theory” influenced many following studies on sport-science as a potential prediction-model that tries to explain human ability in facing inexperienced problems.

The other applied areas of the field cover widely such in brain-science or control model of motor-actions, training menu or analytics of motions in sports and so forth. In respect to physical learning domain, many approaches combines sports-science and learning-science.The outcomes of them sometimes contribute to physiotherapy and other practical area.

Most of the skill transferring media from one to another is language. Skill itself is commonly said as practical actions in acquisition and development of the higher knowledge and motor-actions that are acquired only in case learners practices them repeatedly.In this sense, the meaning of skill always involves relative perspectives interpersonally. In addition, it sometimes implies potential change as well as the performance/reaction change as seen in personnel growth. The major stream of growth takes place by the direct experience of practice or the empirical impact in the real situation. However, some skills are developed through the indirect experiences that are transferred by a linguistic way. The audio and visual media in addition to the language become more popular than ever before because of the rapid expansion of social traffic on the Internet.

One of the sophisticated researches for acquisition and development of motor-skill is a linguistic approach that incorporates meta-recognition. Metacognition is a complex concept but today’s

major stream in this area because it expresses the intuitive relationship between consciousness and a motion trajectory. However, in this approach, the verbalizing by metacognition does not denote its objectives as "holding the consistency and correctness". The essential meaninglying in metacognition of motor-skill is "the tool for discovery". It claims that an appropriate environment is required in understanding the relations between surrounding environment and the physical activity in order to discover new facts in sustainable practices.It is not limited in the individual.A framework to share the facts or the didactic experience with others has been paid attention in the online community. For the sake ofthefascinating translation of understanding facts with linguistic way, the social network is used these days (Wenger et al., 2009).Based on the background discussion described above, as an aidingthe support of physical skills acquisition and development, we apply the web community environment (Matsuura et al., 2011).

The target of our approach is to propose general framework for courseware tools about motor-skill development on the web. As a concrete proposal, well-known taxonomy is adopted that is described in the next section to start with.

2. General Classification of Motor-Skills

2.1 Taxonomy

Domain fields for motor-skill have been spreading widely. Some of them can be evaluated indirectly by the performance data.It is collected in an experiment of the practical fields. Arts or cooking are typical examples on behalf of these skill fields because they are available to be measured by way of the products in addition to the motion analysis.

The challenging attempt in this area is to classify them with common criteria. One option is the length of the trial time for physical motions while many researches focus on intelligence, didactics and senses such in arts (Soga, et al., 2012) or medical fields (Knight, 1998, Majima, et al., 2012). Even being limited within sports, there are long-term skills and short-term ones from a viewpoint of motion time. With the rapid progress of sensing technologies, analytical approaches on short-term skills are paid attention gradually (Kishimotoet al., 2012).Ball kick in football (Williams and Reilly, 2000), hokey (Stephen, et al., 2004) and table tennis (Maaty, et al., 2011) are typical examples in such fields. On the other hand, we focus on long-term skill that comprises the series of motions. Our concrete target-motions are rope-skipping or juggling ball of which actions need repeating actions.

Skill acquisition in short-term category sometimes has its breakthrough trigger, which is hard to catch up with the system automatically because of its unexplained mechanism. On contrary, skills in long-term category often require matured practices of many times. In addition, some skills have their systematic process from the easiest one to more complex one. For example, rope-skipping techniques usually start with overcoming the basic jump. Then, one who mastered the basic jump proceeds to the next stage such in alternate foot jumping or front-back cross and so forth. Since such a process has the common direction from the basic one to the complex one, we can make subdivision and materialization of the conceptual skillin a supporting system.

The well-known discussion on general taxonomy of the growth process derives from Gentile (Gentile 1972). It has two basic axis thereof; i.e. (a) environmental context and (b) function of actions. Environmental context (a) can be divided into further two types with two variability; in-motion and inter-trial with whether the same condition are set or not. Likewise in terms of (b), two variability in two further subdivision are proposed wherein object manipulation is required or not. The overall criteria are listed up in table 1.

Combining these items make us enable to set up two dimensional subdivision table with total sixteen cells therein.Some researchers suggest the application about the table that helps step-by-step development is feasible and then the performance through the process can be improved. Therefore, we adopted the two dimensional taxonomy for supporting skill development framework. In addition, we propose the navigating strategy for learners in this general framework. The system itself is designed and implemented on a social networking system that is available to offer members to communicate among them.

Table 7: Criteria in Gentile's general taxonomy of motor-skills

No	Item	Axis description
(1)	In-motion & same condition	(a)
(2)	Inter-trial & same condition	(a)
(3)	In-motion & different condition	(a)
(4)	Inter-trial & different condition	(a)
(5)	Manipulating object none &Moving from the original position	(b)
(6)	Manipulating object exist &Moving from the original position	(b)
(7)	Manipulating object none & Keeping the standing position	(b)
(8)	Manipulating object exist &Keeping the standing position	(b)

2.2 Task assignment

Following to the introduction of the general taxonomy, Table2 illustrates the assigned cells in a whole process. The number in each cell refers those in Table 1. To start with, the easiest skill-level is located in ((1)&(5)) where novice learner should begin the training. The most complex one is in ((4)&(8)) where the learner completes overall training with this courseware.

An organizer of the total trainingselects the total skill.Then s/he can subdivide it in each cell based on the combination of each item of criteria. When the content in ((1)&(5)) is defined by the organizer, the other cell-contents can be systematically fulfilled. For example with skipping-rope of single, the first goal of the subdivided training might be “keep jumping at constant timing at fixed location without rope”. Then, the final goal of the last training might be “alternate step-jumping with a rope at inconstant rhythm served by the third person with moving location”.

Table 8: Whole view of Gentile taxonomy

			(b)Function of actions			
			NOT Moving		Moving	
			NOT Manipulate obj.	Manipulate obj.	NOT Manipulate obj.	Manipulate obj.
(a)Environmental context	Same cond.	In-motion	(1)&(5)	(1)&(6)	(1)&(7)	(1)&(8)
		Inter-trial	(2)&(5)	(2)&(6)	(2)&(7)	(2)&(8)
	Diff. cond.	In-motion	(3)&(5)	(3)&(6)	(3)&(7)	(3)&(8)
		Inter-trial	(4)&(5)	(4)&(6)	(4)&(7)	(4)&(8)

In practical situation, the organizer does not have to fulfill all the sixteen cells in an affected manner. The organizer should design them as a feasible contextwithout any unnatural manner. Our belief is that the important policy should be coherence in the total process. In concrete, the motion without any manipulating object such in Karate, the organizer does not need to consider the rowsof (6) and (8).

3. Design and Implementation

3.1 Design Principle

The basic idea to implement the navigating system along with the discussion above, we have decided to adopt the platform in SNS, Social Networking Site. The reasons are as follows;
(1) Open source software: It is easy to customize.
(2) Many original functions: We can use the existing tools easily.

Beyond the preserved tools by the framework of OpenPNE by Tejimaya (http://www.openpne.jp), we customized the community space whose functions are defined by the organizer. The organizer should design sixteen cells with contents of detail objectives and training.

3.2 Stored data and the output data

When content of the training in a required cell is defined, the members in a community follow the instruction. The outcome or resulting performance through the training is stored in each cell data via the web-interface. The target training method for the member is produced at every time s/he visits the community space online. If a learner as a member of the community achieved the configured performance of a cell, s/he can proceed to the next training navigated by the system automatically. In other words, a member cannot select the next target task by oneself. Furthermore, the whole view of the process in the series of the training is not elucidated from the bird's eye view. It is because some apprehension of the keeping or raising motivation in case the learner knows their current stage of the skill.In terms of required data for each cell, the organizer has to define following three forms.

(1) Training content: Each learner has to input her/his original training method to the system every time. If the resulting performance is better than ever, the associated training should be focused later on. The combination of the result and the process is sharable with other members in order to give the hint for pull up from the plateau.
(2) The performance data: The data is relevant to both the quality and quantity of the training. Therefore, the numeric value can be compared or calculated for the judgment of the level of achievement to the cell.
(3) Self-evaluation: To give subjective comment, the system provides the self-evaluation form because of the necessity of supplemental data thereof.

3.3 Estimation and Navigation

There are a variety of route from the initial to the goal. In order to provide several options to suggest the next direction from a cell, we have to take into account of avoiding the possible contingency in the performance data rather than the data itself. In other words, with the simplicity comparison method, the learnermay be able to accomplish the task "by chance", but the system should really detect the phenomena in detail a little more whether it is the really clear the subtask or not. Hence, the system offers an input-form of (2) in addition to (3) in order to get enough data at a trial time.

As a general navigating rule, the possible cellsfrom the next three options may be chosen from eight cells which are up to choices of (i+1,j), (i,j+1), (i+1,j+1), when a learner clears (i,j) cell.In the choice of the transition of this time, the most appropriative direction is selected depending on the history of clearing the target task. In addition, the navigating direction of the transition is possiblyback to a former subtask when the learner does not clear the task. In terms of the concrete algorithm, we summarize it as follows;

(A) If there are multiple results of the same exercise, the system divides them into several consecutive blocks and it calculates the average of each block. In this way, the possible contingency decreases. If the individual mean value exceeds against the threshold, the system permits to open the next cell for the learner. The system sets the shortest path (i+1,j+1) to the complexity direction as the next transition.
(B) Then, it is thought that the learneris achieving a subtask more or less when a few values of means aremore than the threshold. In such a case, the system presents the open cell (i+1,j) or (i,j+1).
(C) The system judges that theachievementofthesubtaskrequires a little more exercisewhenthe number ofthe succeeded meansislessthanthethreshold. In such a case,the system shows a self-loop to (i,j), otherwise it provides the possible cell as (i-1,j+1) or (i+1,j-1) to the next cell. These are cells at the parallel position against the direction to (4,4) cell. Gentile taxonomy does not define the firm orders in these categories.

(D) At the last case that all means are under the threshold, the system provides the negative direction to the forward because such a case seems difficult to achieve the given task. Concretely, the system suggests (i-1, j) or (I,j-1) cell to the learner.

3.4 Tailoring the training in a community

It is not limited to motor skills, but physical skills are strongly affected the individuality. Therefore, the functions for the discovery that contributes to the development of own skills are required asa general principle. For example, the equivalent function is seen in the blog space that corresponds in the SNS (Hamagamiet al., 2012). To this, it may give the bright sight to solve the plateau situation. If the learner cannot improve the current skill level even with the repeating training, the motivation of her/his may be also reduced. However,the mutual exchange of the training methods of inexperience or some hints through the SNS might be the triggering opportunity to improve the current stage.For learners from the above discussion, who has remained at the same level subtasks with a certain number of exercising times, weintegrate a social function to see how the others havesuccessfully achieved the target about the same cell.

4. Trial Use

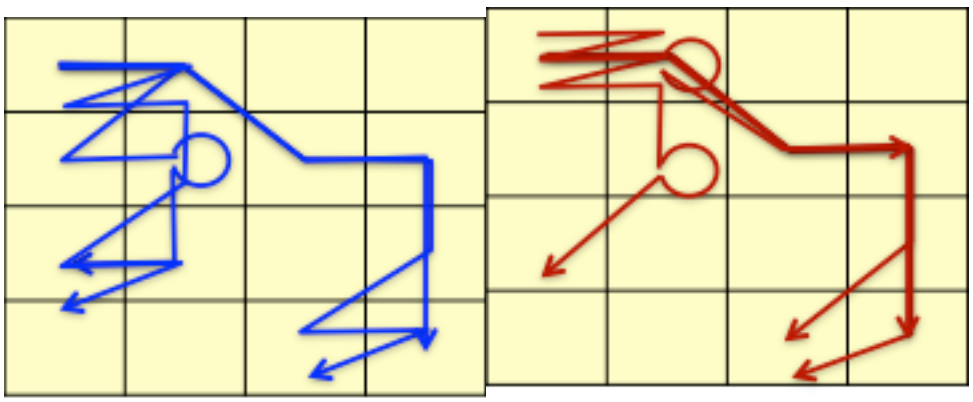

Figure 1. The path of the community members (left:juggling, right: rope-skipping).

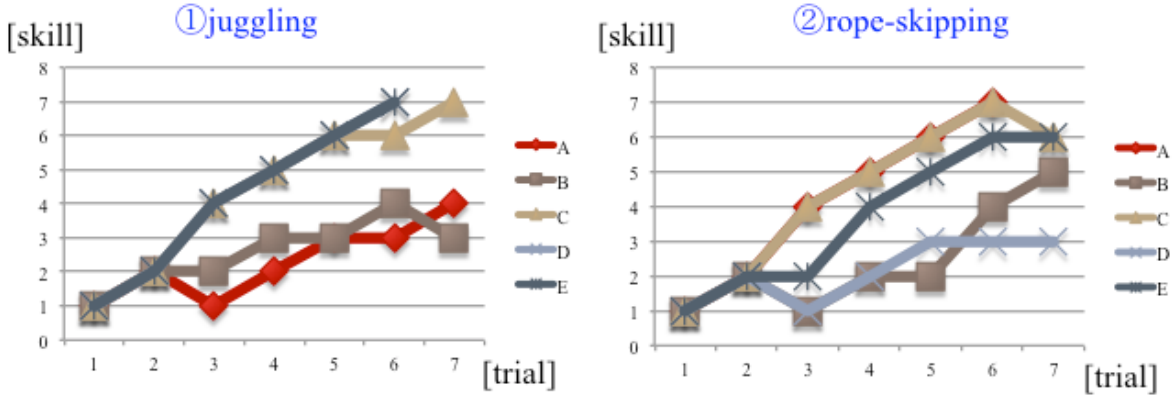

Figure 2.Learning curve following to Gentile taxonomy.

We organized the volunteer subjects for the trial use of our proposal. The number of subjects was five who have similar properties of body, age, and gender. We selected two concrete themes for the skill development that are juggling the football and rope-skipping of single. Both have the common properties that have been discussed already; i.e. long-term skill, repeating actions with manipulating objects, and so forth.

The initial levels about the target skill were almost the same on the analogy of previous interview for each. They started from (1,1) cell that presents the same task to each learner. However, the tasks other than (1,1) are different each other. As learners could not know the final goal task to complete, they follow the presented tasks step by step. The results of a traced path of the subskill process read in Figure 1. The left figure indicates the football juggling while the other one does the rope-skipping, where all the subjects' data were integrated into the same figure.

The result shows that the navigation in our general courseware leaded the learners to the goal properly. Some of them had difficulties to proceed directly to the next positive path; otherwise the others had no problem in terms of the difficulties configured by the organizer. With the taxonomy, the lined cells drawn at a slant from upper-right to lower-left are regarded as the same level. Therefore, when we plot the skill level to be summarized by the result in Figure 1, we got Figure 2 as an implying learning curve in the skill development. From this, most of the subjects gradually proceeded to the final task although they stayed a bit at the same or negative stage for a while.

5. Concluding Remarks

In this paper, we discussed the new proposal for training method of motor skills in the online community environment. Although the current project is still in an ongoing stage, we have developed the prototype system. Using the system, we made some observation and reported obtained data about the growing learners along with our scenario on the social web environment.

We can continuously discuss the future implications as following further issues. We will tackle these themes from now on.

(i) Distinguishing performance from the training
(ii) Integrating adaptation method from technical perspectives
(iii) Effective feedback based on direct motion data

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