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A Failure Event Virtual Learning Method that Replaces Field Experience and Its Effectiveness Measurement

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ABSTRACT

95 % of occupational accidents are said to be caused by unsafe human behavior. In order to prevent occupational accidents, various types of human resource education are implemented in each company, but the current situation is that many of them are aimed only at preventing serious accidents in steady state. One of the reasons for this is that while many companies have substantial training programs that use concrete examples, they still do not have enough training to develop the ability to apply these concrete examples to new cases that they actually face. The ability to accurately summarize concepts from concrete examples and grasp things as a whole is called conceptual skill. Organizations with on - site leaders with high conceptual skills not only have a low occupational accident rate but can effectively organize teams to achieve organizational goals. Therefore, in this study, we will propose a failure event virtual experience-based learning method that enables the development of conceptual skills instead of on-site experience, and measure its effect, by investigating various conventional educational methods. Many text-based approaches, such as interviews and questionnaires, have been conducted in order to acquire workers' conceptual skills, but there are still few examples of behavior-based study. Therefore, in this study, we propose a conceptual skill acquisition support method through analyzing conceptual skills from the behavior of subjects.

Keywords: Field experience, Experience-based learning method, Conceptual skill

INTRODUCTION

When humans work on a new requirement, instead of creating a new working solution from a blank slate, a similar design that derives a working solution by making use of specific cases experienced in the past and partially modifying them. That is, the work is often guided by past examples and experience.

A knowledge-based approach is one of the techniques for humans to generate working solutions from such concrete examples. This is a method of collecting specific past cases and inductively extracting knowledge from a large number of cases and reflecting it in the work. In addition, when solving an unknown problem, store typical cases, search for known problems similar to the problem, and transform the solution case for the known problem to

obtain the solution of the problem. The use of case-based reasoning is also often seen.

In order for the recollected experiential event to contribute to the appropriate coping with the immediate situation, these approaches are based on the idea that the immediate situation and the recollected experiential event are not only superficially similar, but are highly sensitive. Recognizing that they are equivalent in the following relationships: In this way, while accumulating concrete experiences, humans need to abstract those experiences, go beyond superficial understanding, and acquire high-level learning. However, in actual company education, while there is substantial education in specific cases such as OJT (on the job training) and new employee training, it is important to abstract the knowledge learned there and grasp the essence of things. However, many of them have not yet developed the skills that can be used in other situations. The purpose of this study is to form human resources with such high conceptual skills, and to develop general skills that can be utilized in various tasks.

CONSIDERATION OF CONCEPTUAL SKILL DEVELOPMENT METHOD AND EFFECT MEASUREMENT METHOD

Educational Effects Targeted in This Study

Among the workers working in the field, the field leader who brings together the entire organization is particularly required to have conceptual skills. By referring to the past literature on management science and organizational psychology, and sorting out the characteristics required of on-site leaders, the characteristics were classified into 4 major categories: work performance, organizational behavior, management, and improvement, and 20 skills. (Table 1) In this study, we aim to expand the characteristics of work performance among the items classified into four categories. The reason for targeting work performance characteristics is that it is the most fundamental characteristics for on-site leaders to manage work, and in order to effectively utilize the given situation to carry out work, It is essential to form a conceptual skill to grasp things as a whole (Table 2).

Task Requirement Definition

Task requirements necessary to quantitatively evaluate work performance characteristics (five skills in Table 2) are summarized below. (Table 3) We thought that each subject's competency would be conspicuously reflected in their behavior by performing tasks that meet the following requirements.

Design of the Experimental Task

This study focuses on two skills: "situation awareness management skill" and "workload management skill". The reason why these skills are targeted is because they are skills that are used not only in team task but also in individual task, so we judged that they are important skills in a wide range of work. As for the task content, the experiment is designed assuming the assembly task performed in the manufacturing industry and factories. It is

Table 1. Characteristics required for on-site leaders.

Characteristics	Explanation	Skills
work performance	Skills to effectively utilize all available resources (people, equipment, information, etc.), to combine the strengths of team members, and to improve team performance.	communication skills decision making skills workload management skills situational awareness management skills team formation/maintenance skills
organizational behavior	Any action taken by an employee that is not a requirement of their formal job function and that facilitates the effective functioning of the organization. In other words, the consciousness and attitude to work on things other than what has been decided.	personal assistance Honesty organization support behavior cleanliness professional consideration
management	Findings about "challenges in the manager transition process" such as the dilemma of entrusting work to subordinates and the anxiety and rejection of becoming a manager, which are felt by excellent players.	skin peeling experience in the transition to becoming a manager consciousness change in the transition to admin identity change dilemma for managers
improvement	New ideas for the development of products and services necessary for companies to develop new markets, create new products and services, and improve existing systems to achieve further growth and development through management innovation. proposals for improvement and reform of production methods and regulations, and actions that give top priority to customer needs.	problem finding and resolution collecting important information customer priority action organization and surrounding support behavior diligent behavior Ideas and Suggested Actions

necessary to perform not only the actual process, but also the presumed and subsequent processes, and the need to grasp the situation of the part where you are not working. Since assembly task is set as the target task. The experimental task is designed as follows so as to meet the requirement definition. (Table 4).

Creation of Reference Words and Checklists for Subject Behavior

Based on the explanations written in past literature, we summarized how the elements of the two skills appear as descriptions and created reference words. Furthermore, based on the skill elements and reference words, we created a checklist of subjects' behavior corresponding to each skill element so that it could be applied in this experiment (Table 5).

Consideration of Conceptual Skill Development Method

In examining the Conceptual skill development method, we referred to safety management courses that are actually being conducted at railway operators

Table 2. Skills related to work performance characteristics.

Skills	Explanation
communication skills	Skills to convey and exchange information in order to communicate with staff, and to make appropriate claims and statements for safety.
decision making skills	Skills related to the process of involving all members of the team in problem solving, reliably implementing decisions, and providing feedback on their actions.
workload management skills	Skills to form and maintain a more effective proposal team in order to achieve safe and effective work
situational awareness management skills	Skills to keep the amount of work appropriate and to carry out tasks reliably within the given time
team formation/maintenance skills	Skills to recognize the situation in the field with attention and maintain situational awareness by avoiding one-pointed concentration and prejudice.

Table 3. Definition of task requirements.

Task requirements		Reason	Evaluable skills
no manual		In task with a manual, subjects can perform the task according to the manual, so there is no difference in behavior between subjects. For task that does not have a manual, it is necessary to think about task procedures on your own, so people with high work performance characteristics can take action by gaining new insights in the process.	decision making skills situational awareness management skills
have a clear goal		In task with a clear goal, subjects need to think about the path toward the goal in order to succeed in the task, so the level of work performance characteristics is conspicuous.	communication skills decision making skills workload management skills
loose time limit prepare		In an environment where time constraints are too strict, subjects may not be able to demonstrate their work performance characteristics due to impatience. On the other hand, situations where time is set to be unlimited are extremely rare in on-site work, and lead to a decline in concentration. By setting loose time constraints, we will create an environment where they can demonstrate their work performance characteristics.	workload management skills situational awareness management skills
selected by skills to be measured	individual task	Team task is not suitable for accurately measuring the work performance characteristics of the target person, as multiple people share their awareness as they proceed with the task. Therefore, the two skills on the right are evaluated by individual task.	workload management skills situational awareness management skills
	team task	three skills on the right are skills that are demonstrated in team task, so they are evaluated through team task.	decision making skills communication skills Team formation/maintenance skills

Table 4. Design of the experimental task.

Task requirements	Design of the experimental task
no manual	No manual is distributed, only images of the completed model are distributed to the experimenters, and the procedures up to completion are designed to be considered by the subjects themselves.
have a clear goal	subjects are shown the image of the finished product and instructed to reproduce the finished product. In this experiment, if the completed form can be reproduced, it is considered a success, and if not, it is considered a failure.
set a loose time limit	By having several people cooperate in advance and have them do the same task as the experiment, we set an appropriate task time to complete the task with plenty of time.
individual task	Subjects are provided with only completed images and perform the assembly task by themselves.

and medical sites. As a result of a survey of the courses offered by these companies, it was found that on-site instructors analyzed the causes of incidents and identified the skills required of on-site instructors based on four items (expressiveness, logic, diversity, and versatility). It becomes clear that they are being evaluated.

In this study, by presenting four items and explanation materials for each item without explaining anything to the subjects, we decided to verify what kind of changes in the behavior of the subjects before and after the learning.

VERIFICATION EXPERIMENT

Experiment Overview

It is assumed to be the assembly task performed in the manufacturing industry and factories. Based on the image taken from one direction of the completed form distributed in advance, the test subject assembles the parts and reproduces the completed form. In this experiment, the parts are designed to be easy to assemble without the use of tools, etc., in order to eliminate differences between subjects due to manual dexterity in assembly. Based on the behavior of the subjects during the task, we analyzed how many of the seven checklist items in Table 5 were true and recorded the success/failure of the task. Success in this experiment is defined as being able to reproduce the completed form in time. In addition, the state of the task was filmed with a video camera.

subjects were **2** undergraduate students (mean age: 20.5 ± SD 0.71, mean height: 172.5 cm ± SD 2.12, 2 men).

Experiment Environment

The experiment environment for verification is shown below (Fig. 1). In the initial area, the parts before assembly were arranged according to the type of parts. Using the parts in the initial area, the subject reproduces the finished form in the assembly area. In addition, a timer was placed in a place that

Table 5. Reference words and subject behavior appearing in each skill element.

Skills	Each skill element	Reference word	Subject behavior
workload management skills	Planning	plan, prepare, just in case, in advance Change, Anticipate, Prepare time, opportunity, timing	Instead of moving his hands immediately after starting task, he takes the action of thinking for a certain period of time.
	Prioritizing	Priority time, amount of tasks, workload emergency, abnormal	While checking the time during task, he sets the priority of assembly.
	Distribution	Allocation monitor, watch, Auto, AI, Drone	The completed form is divided into small parts for task.
situational awareness management skills	Monitor	Sharing discomfort, symptoms, and perceptions mode, state	The task is progressing while frequently checking whether the task working on is correct.
	Vigilance	immersion, concentration normally Discomfort, situational awareness timing, right	If he makes a mistake, he can immediately recognize it and make a recovery.
	Anticipation	predict if	The parts are carefully arranged in case the assembled product breaks.
	Analysis	Information gathering Consideration	He stops and takes the time to check the finished drawing, which is the number one source of information.

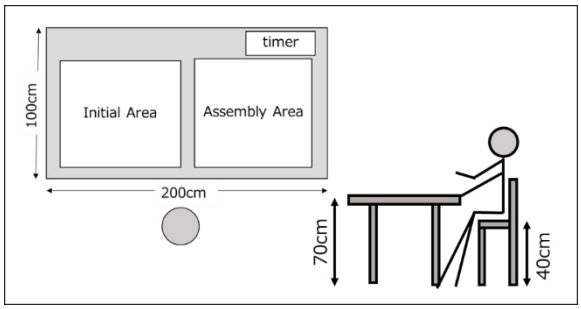

Figure 1: Experiment environment.

would not interfere with the task, so that the subjects could grasp the task time.

In addition, in order to reduce fatigue of the operator, this experiment was conducted in a sitting position, and the heights of the task table and

chair were set at 70 cm and 40 cm, respectively, which are considered appropriate heights for a typical Japanese adult male. and set up the verification environment.

Experiment Flow

The experiment flow for verification is shown below (Fig. 2). At the beginning, the subject was given an explanation of the purpose of this task, simply to "assemble and reproduce the parts according to the distributed image". After that, three minutes of learning time is provided, and the shape of the part is grasped. As for the shape grasp, it was difficult to grasp the difference in shape of many parts just by looking at them, so we allowed them to actually hold them in their hands and check them. After that, a experiment is conducted, and the subject assembles the parts in the Assembly Area in 30 minutes. After a 15-minute break, the subject reads and learns the materials in Table 6 for 5 minutes. After learning, a similar experiment is performed. After the 1st and 2nd experiments, we will interview the subjects about what they noticed during the experiment.

Experimental Result

Based on the motions of the subjects filmed with a video camera, we analyzed the number of fits to the seven behaviors of the subjects in Table 5. As a result, the average number of fits increased by 0.5, as shown in Fig. 3. As

Table 6. Materials shown to subjects.

Skills required for on-site instructors	Explanation
expressiveness	The ability to convey one's own experiences and observations to a third party in an easy-to-understand manner. Even if you have a realization within yourself, if you can't properly communicate that realization to those around you, the realization will be your own, and the effect will be halved.
logic	Ability to not only intuitively perceive one's own perceptions, but also to think about background factors. The ability to think logically is of course useful during work, but it also has the advantage of increasing your persuasive power when communicating your thoughts to those around you..
diversity	The ability to think about things from other people's perspectives based on what you notice while working. Being able to take a bird's-eye view of work from the standpoint of various people is something that cannot be achieved without a broad perspective, and is a higher skill than the above two items.
versatility	The ability to discover new insights that can be applied to other work through experienced work. This is the highest skill of the four items.

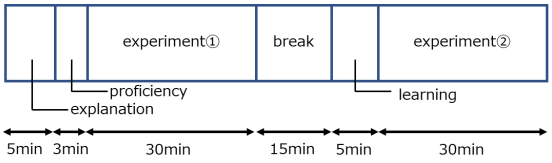

Figure 2: Flow of verification experiment.

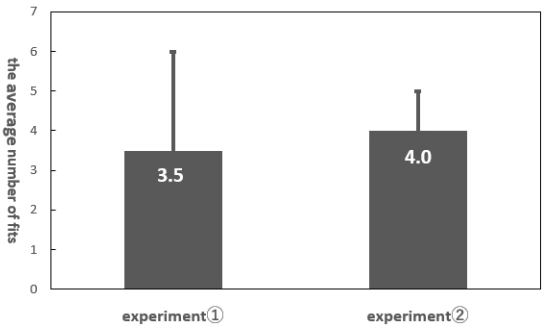

Figure 3: Average number of fits to seven behaviors.

a reason to the increase in the number of fits, the subjects who failed were able to change the actions that were applicable in experiment with respect to "Distribution", which is an element of workload management skills, and "Anticipation", which is an element of situational awareness management skills. In other words, it is thought that learning has given them the ability to think logically about the path to achieving their goals, and that they have become able to act while anticipating what will happen in the future.

On the other hand, some problems were observed. The first is the decrease in the number of subjects who were successful in experiment①. In experiment①, "Planning", which is an element of workload management skills, was completed, while in experiment②, task was started immediately without thinking. This test subject also succeeded in experiment②, and the task time from experiment① to experiment② was reduced to 1/3 or less, so the task efficiency was significantly improved. However, there is a concern that the word "easy" appeared five times in the interview after experiment②. Doing a task while thinking it is easy leads to ruts and overconfidence in the task, which entails the risk of making a serious mistake. Second, none of the subjects improved their skill elements in "Planning," "Prioritizing," "Vigilance," and "Analysis." In particular, regarding "Prioritizing", neither of the subjects could have it in experiment ① and ②.

this method was confirmed to be somewhat effective for subjects with low workload management skills and situational awareness management skills, it is necessary to take a new approach for subjects with high these skills. will be an issue for the future.

CONCLUSION

In this study, we proposed a conceptual skill acquisition support method that is especially required for leaders of organizations such as field leaders. In

order to acquire conceptual skills, we focused on "workload management skills" and "situation awareness management skills", which are skills that are used in individual task, aiming to expand the subject's work performance characteristics. Through the experiment, it was confirmed that the behavior of subjects who lacked these skills changed and that they were able to draw a path toward achieving their goals.

Since we were able to confirm a certain effect in individual task, it is suggested that the learning method proposed this time could contribute to the expansion of the work performance characteristics of workers for general field work. However, since improvement was not seen in four of the seven skill elements mentioned, it is necessary to consider further enhancing the explanation, such as giving specific examples of skill utilization in the explanation content of the material. In addition, it was found that there is room for consideration in educating human resources who originally have high conceptual skill.

As a future issue, it is necessary to consider effective learning methods for all seven skill elements, and to consider a conceptual skill acquisition method that takes into account the skills exhibited in team task, which was not the subject of this study.

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