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Original Article

A Quantitative Team Situation Awareness Measurement Method Considering Technical and Nontechnical Skills of Teams

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ABSTRACT

Human capabilities, such as technical/nontechnical skills, have begun to be recognized as crucial factors for nuclear safety. One of the most common ways to improve human capabilities in general is training. The nuclear industry has constantly developed and used training as a tool to increase plant efficiency and safety. An integrated training framework was suggested for one of those efforts, especially during simulation training sessions of nuclear power plant operation teams. The developed training evaluation methods are based on measuring the levels of situation awareness of teams in terms of the level of shared confidence and consensus as well as the accuracy of team situation awareness. Verification of the developed methods was conducted by analyzing the training data of real nuclear power plant operation teams. The teams that achieved higher level of shared confidence showed better performance in solving problem situations when coupled with high consensus index values. The accuracy of nuclear power plant operation teams' situation awareness was approximately the same or showed a similar trend as that of senior reactor operators' situation awareness calculated by a situation awareness accuracy index (SAAI). Teams that had higher SAAI values performed better and faster than those that had lower SAAI values.

1. Introduction

Individuals have their own strengths and weaknesses. Those strengths become more powerful when strengths are assembled; the so-called "synergy effect". Sometimes, one person's strengths complement another's weaknesses. Team members can give warnings to each other and correct other members' abnormal behavior and opinions by offering other points of view so that human error can be prevented or, at least, serious consequences caused by human behavior can be mitigated. In addition to these general reasons, running nuclear power plant (NPP) systems is beyond a single person's ability. Thus,

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NPPs are basically designed to be run by people with various specialties and abilities working together. Normally, NPP operation skills are composed of technical and nontechnical skills. Technical skills deal with areas of science related to plant operation [1]; nontechnical skills are areas of sociology related to information exchanges among plant operators [2]. In our previous research, evaluation methods for both skills have been proposed; however, the proposed methods have two critical disadvantages in any sort of direct application in team evaluation. First, the proposed technical skills evaluation method was originally developed for the evaluation of individuals; separately evaluated results for operators should be put through a comparison analysis. Another problem is that technical skills and nontechnical skills should be collectively analyzed, because they are not mutually exclusive. In this paper, an integrated skill training model and a team performance evaluation method that considers the interdependency of technical and nontechnical skills are suggested.

2. Development of an integrated training model

No adequate training model for NPP operation teams has been developed. Fortunately, the design of technical skills training, such as technical lectures and simulation-based training to deal with abnormal situations, can be based on a systematic approach to training (SAT). Likewise, the design of nontechnical skills training requires a framework. Furthermore, the integrated skill training model will help improve the operation skills of personnel.

2.1. SAT

SAT is defined as a "logical progression from the identification of competences to the development and implementation of training towards achieving these competences" [3]. SAT-based training is recommended by the International Atomic Energy Agency (IAEA)a for the training of NPP personnel. It is also a requirement/standard in most countries in which NPPs operate. This is codified in the safety guide as follows: "a systematic approach to training should be used for the training of plant personnel." [4].

The purpose of training is to learn something, so after training, evaluation must be put into place to check how much trainees have learned and to modify training to yield better results from the next training. One cycle of such steps is called a learning unit (LU). The LU is a formulation that facilitates change, a change that will result in the trainee being able to do something he/she could not do before going through the LU. In other words, the LU facilitates a change in behavior. There are four principal stages in a typical LU model as shown in Fig. 1 [5]. The steps are summarized as follows. (1) A training objective must be set before training. (2) Trainers need to know the level of trainees. This step requires the use of an evaluation method. (3) Trainers conduct training. (4) Performance should be assessed to check the effect of training.

A typical LU of SAT is shown in Fig. 2. Actually, the IAEA recommends that training courses and seminars on management and supervisory skills, coaching and mentoring, self-assessment techniques, root cause analysis, team training, and communication be developed based on SAT. Most of the items mentioned here are related to nontechnical skills. Unfortunately, nontechnical skills training has been overlooked in Korea and thus, no well-developed nontechnical skills training programs based on SAT, nor evaluation methods, are currently applied to further improve the operation skills of NPP operation teams. Therefore, SAT was applied to the development of simulation training and technical and nontechnical skills evaluation processes in this research.

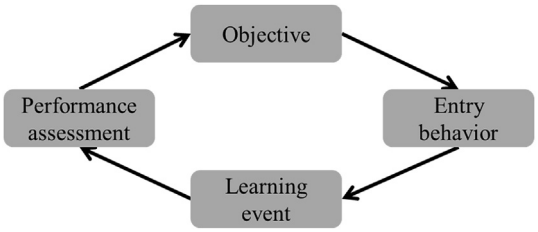

Fig. 1 – A simple model of a learning unit.

2.2. *Integration of technical and nontechnical skill training*

Training systems in the nuclear industry are somewhat biased toward enhancing technical skills. For example, nontechnical skill training has been given in one-off seminars in Korea. Most of the training sessions related to the operation of NPPs utilized virtual reality running on a simulator. Thus, for efficiency's sake, the evaluation of technical and nontechnical skills together in one session of simulation training is necessary. A new model of skill training and evaluation processes is required to properly integrate and evaluate these two disciplines; such a model should be able to consider the interdependency of these skills. Interdisciplinary training is "a process of answering a question, solving a problem, or addressing a

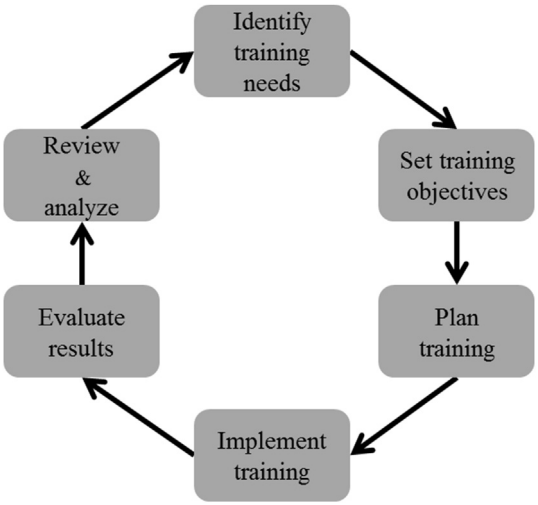

Fig. 2 – A typical LU of SAT. LU, learning unit; SAT, systematic approach to training.