

# Board Game: An Effective Way for Novice Trainees to Learn Incident Command System

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**Abstract:** The incident command system (ICS) is widely used in disaster management, but it is hard for novice learners to apply what they learn in actual practice. Considering these aspects, we developed a board game for novice learners to learn ICS and conducted a study to evaluate the effectiveness of the board game method compared with that of traditional lectures. Two sessions of ICS training were conducted using only board games and lectures for each session. In the board game session, the participants played the board game for 1.5 hours without receiving any teaching. The game participants played as disaster response teams based on ICS principles. In the lecture session, a didactic lecture on ICS concepts and their applications in disaster medical assistance team (DMAT) work was taught for 1.5 hours by a disaster medicine expert. Before and after each session, a test comprising 20 multiple-choice questions (5 points for each question) was conducted. In the test, participants were evaluated on how to apply the ICS principle to DMAT work. Participants who had not previously received any disaster medicine education were defined as novice learners and were included to compare the learning effects of the two methods. A paired t-test was used to compare the results within each group, and an analysis of variance (ANOVA) was used to compare the results between the two groups. The study included 17 participants in the board game group and 25 participants in the lecture group. The mean test score was significantly higher after the game and the lecture (pre-game score = 56 versus post-game score = 75, p-value = .001; pre-lecture score = 58 versus post-lecture score = 74, p-value = .002). No significant difference was found in the score improvement between the two groups (p-value = .6). Hence, we can conclude that learning ICS through board games was as effective as using the traditional lecture method for novice disaster medicine trainees. The board game is a useful tool of disaster medicine education.

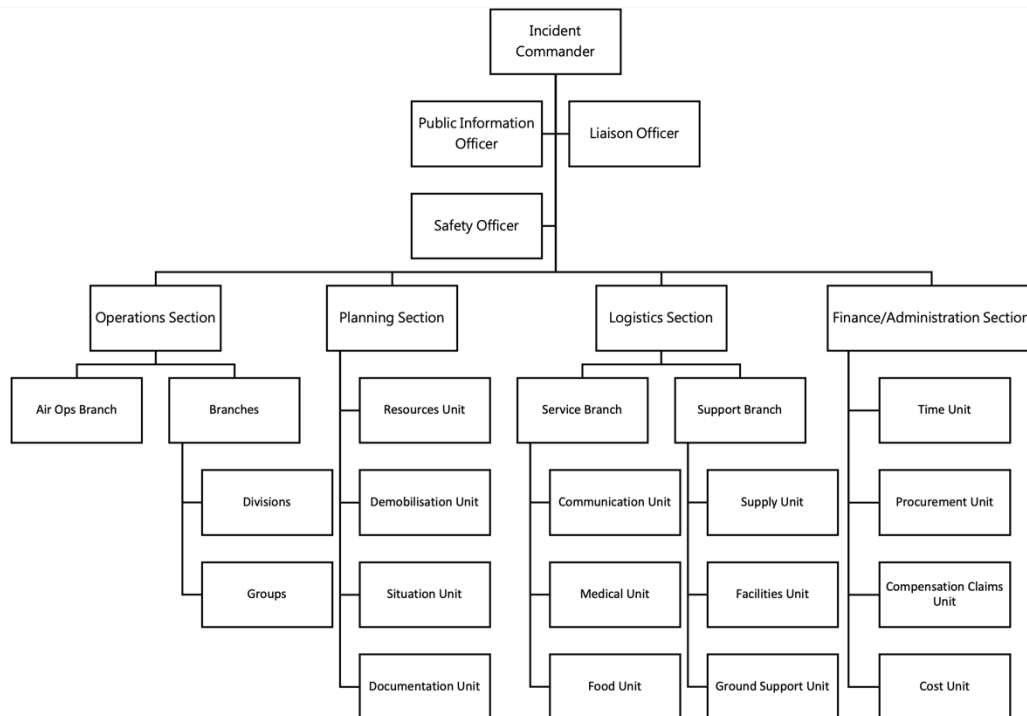
**Keywords:** Disaster medicine, board game, incident command system, disaster medical assistance team

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## 1. Introduction

Disasters occur frequently in Taiwan, which can cause damage. When it happens, a disaster medical assistance team (DMAT) is sent to the disaster scene to provide healthcare. A DMAT usually comprises a variety of healthcare professionals with different backgrounds and specialties, and a command system is needed to organise the team. In Taiwan, the incident command system (ICS) is commonly used to organise the DMAT. The ICS, which is a standard element of incident management utilised by emergency management and response personnel as a tool to coordinate equipment, facilities, personnel and other resources during an incident, has proven to be a robust system and has been adopted by public health agencies (Granillo et al., 2010). This command system contains four sections and command staff. Each section can be further divided into several branches or units (Figure 1). The tasks of each command staff, section, branch and unit are specific and different, but all sections and staff need to collaborate to complete the mission. Despite being commonly used in emergency management and taught in disaster medicine education, ICS is hard for a DMAT novice to learn. Not only do DMAT members need to understand the ICS concept, but they also need to be able to use the ICS and work with others. Therefore, ICS education has become a fundamental part of DMAT training.

Traditionally, the use of the ICS has been taught through lectures and practice and evaluated via disaster exercises. However, traditional didactic teaching has been linked to low knowledge retention rates and poor participant engagement (Bangalee et al., 2021). Research has suggested that while disaster medicine training may require replicating a learning environment to simulate a disaster scene, true disaster cannot be fully achieved in the real world (Knight et al., 2010). However, learning by game-playing has been deemed to have great potential compared to traditional learning (Moradian and Mehraein, 2019), proven to be an effective method for engaging students (Kang et al., 2013) and shown to create a risk-free environment for decision-making and problem-solving learning (Karbownik et al., 2016). Considering that board games have been used successfully as educational tools in several healthcare settings (Yoon et al., 2014), we designed a board game for DMAT trainees to learn ICS. By playing the game, trainees can learn how ICS works and become more skilled as they play (Knight et al., 2010).



**Figure 1:** ICS containing command staffs, sections, branches and units.

By contrast, other researchers have claimed that there is no strong evidence for the use of educational games as learning tools (Karbownik et al., 2016) and that current scientific data neither confirm nor refute the utility of educational games as a teaching strategy (Karbownik et al., 2016; Akl et al., 2013; Akl et al., 2010) compared with traditional methods. Some research has even indicated that traditional lectures are more effective in increasing student knowledge compared to learning by a board game alone (Charlier and De Fraine, 2013), while other research has shown that games are used merely as supplemental teaching tools in education (Bochennek et al., 2007) but not as primary tools. Currently, there has been no study of the effectiveness of learning ICS through games. Therefore, we aim to determine the pure effectiveness of games for ICS training, especially for trainees who have not received any previous ICS or disaster medicine education. To achieve this goal, we conducted a study to compare the effectiveness of ICS learning by game playing with that by traditional lectures.

## 2. Methods

### 2.1.1 Game design

We developed a board game to teach ICS. We created a board game with a simulated town (Figure 2) containing several buildings with different numbers of residents in each building. An earthquake played by an instructor struck the town. The game was turn-based, and in each run, the instructor enacted a variety of disasters, such as building damage, floods, mudslides, fire, communication interruptions and chemical spills. Each turn represented 12 hours in that game, and the weather and day–night status changed each time, causing further impacts on the town or participants. As some specific impacts also had knock-on effects, such as impacts on a thermal power station leading to power outages in the town, the players needed to be aware of such impacts in their disaster response.

The game participants played as disaster response teams, with each team comprising 15 to 25 participants. The roles of this team were set based on a simplified ICS (Figure 3). Therefore, each participant took on a certain role in the ICS structure and performed the task defined by the role. The participants were required to save the lives of town residents, repair the damages and protect the team from harm. The operations section aimed to save the lives of town residents and remove impacts, such as fire, flood or chemical spills. Each branch of the operations section had different abilities to perform specific tasks. The planning section needed to collect information, analyse the situation and provide suggestions to other team members for decision making. The logistics section needed to buy supplies to improve the capability of disaster response. A disaster response fund, controlled by the finance section, was given to the team to improve response capacity, gather information and buy supplies. The command staff needed to protect team members, reach outside resources, deliver public

information, command and coordinate each section, and make the final decision of response in each run. Each run comprised only 10 moves, so the participants needed to work together to consider what moves should be made based on limited information and funds and to accomplish the task (Figure 4).

The participants were briefed on the game rules for 10 minutes and the rules were posted on the wall. The game lasted for one and a half hours. The participants completed six to eight runs during the game period, depending on their response speed. At the end of the game, the number of lives taken by the disaster and saved by the participants was scored as the final result for each team.

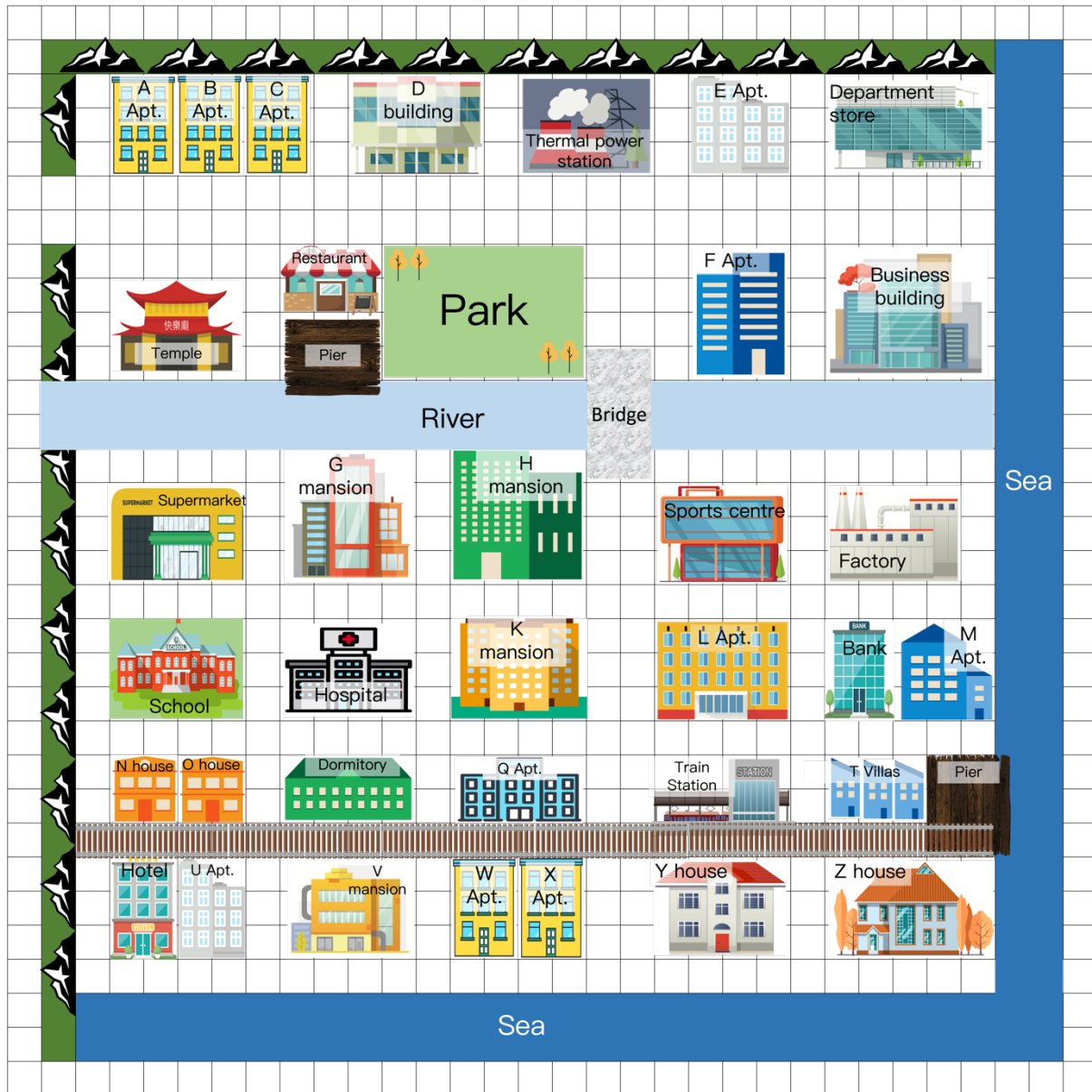
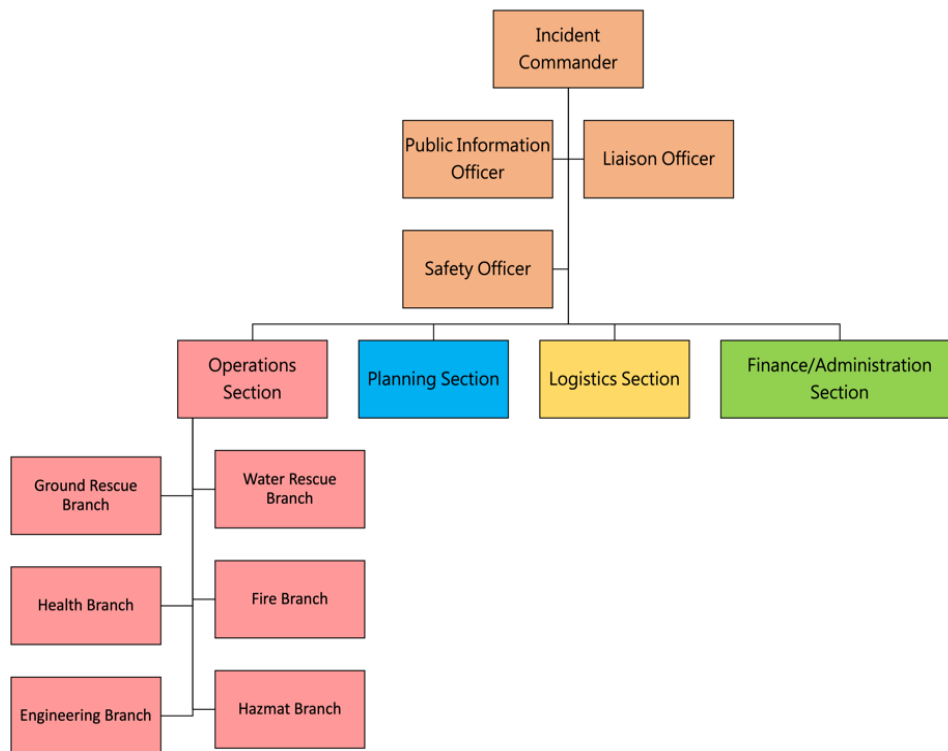


Figure 2: The game board showing a simulated town. (Apt. = Apartment)



**Figure 3:** Simplified ICS used in our board game.



**Figure 4:** Game participants in different sections worked together to accomplish the task.

### 2.1.2 Study design

The DMAT training was conducted in 2020 and 2021. In the 2020 course, the ICS board game was used in the training. In 2021, a lecture on ICS was taught via a DMAT training course by a disaster medicine expert on the content of ICS concepts and their applications in DMAT work. Both courses contained an educational intervention through lectures and game methods for 90 minutes.

Before the game or lecture, a demographic questionnaire was used to collect relevant information, including age, gender, occupation and previous experience with disaster medicine training. A test was designed based on previous DMAT experience using ICS. A disaster scenario that required a DMAT was set in the test, and the questions asked participants about how to apply ICS to DMAT work. The test included 20 multiple-choice

questions. A correct answer was given five points, and an incorrect answer received zero points. All trainees who attended the DMAT ICS training were invited to complete the test before the training to determine their prior knowledge. The same test was used immediately after the game or lecture to evaluate the effectiveness of the training session. Because of the reason for the research, the debriefing and discussion of the game were conducted after the post-test. The test was conducted through Google Forms. Different Google Forms were used before and after the lecture and game-playing. The participants cannot change their answer after the lecture and game-playing. Novice learners were defined as trainees without previous experience in disaster medicine training. Novice learners who completed the questionnaire, pre-test and post-test were included in the study.

### 2.1.3 Analysis

Within each group, the differences between the pre- and post-test scores were analysed using a paired *t*-test. An analysis of variance (ANOVA) was used to compare the results between the two groups. The difference was considered to be statistically significant at a level of  $p < .05$  (two-tailed).

### 2.1.4 Ethical statement

The study protocol was approved by the institutional review board of the National Taiwan University Hospital. Oral informed consent was obtained from all subjects prior to enrolment. To protect the privacy of the participants, all questionnaires were filled out anonymously and the researchers kept all data confidential. The survey and test results were used only for the study.

## 3. Results

Of the 75 trainees who attended the DMAT training in 2020, 17 were novice learners and were included in the study as the board-game group. In 2021, 85 trainees attended the DMAT training. Of these, 25 were novice learners who were included in the study as the lecture group. All novice learners in both groups completed the questionnaire, pre-test and post-test. The majority of the participants were nurses. Table 1 shows the demographic characteristics of both groups.

**Table 1:** Demographic characteristics of the participants

Variable	Board-game group (N = 17)	Lecture group (N = 25)
Age		
<30	2	11
30–50	10	14
>50	5	1
Gender		
Female	12	20
Male	5	5
Occupation		
Medical doctor	2	1
Nurse	11	19
Other	4	5

Table 2 shows the scores for the pre- and post-tests. The mean pre-test scores were 56 and 58 in the board-game group and lecture group, respectively. The mean post-test scores were 75 and 74 in the board-game group and lecture group, respectively. Therefore, the pre- and post-test scores for both groups were similar and the scores improved significantly in both groups ( $p < .05$ ). There was no significant difference between the board-game group and the lecture group in score improvement ( $p = .6$ ).

**Table 2:** Mean scores of the pre- and post-Test

	Board-game group	Lecture group
Pre-test score	56	58
Post-test score	75	74
<i>P</i> -value	.001	.002

## 4. Discussion

The DMAT can be employed to provide medical care after all kinds of disasters, ranging from terrorism to natural disasters. Regardless of disaster type, a robust command structure is essential for successful DMAT work. However, due to the rarity of disasters and deployment, DMAT members may be unfamiliar with the command

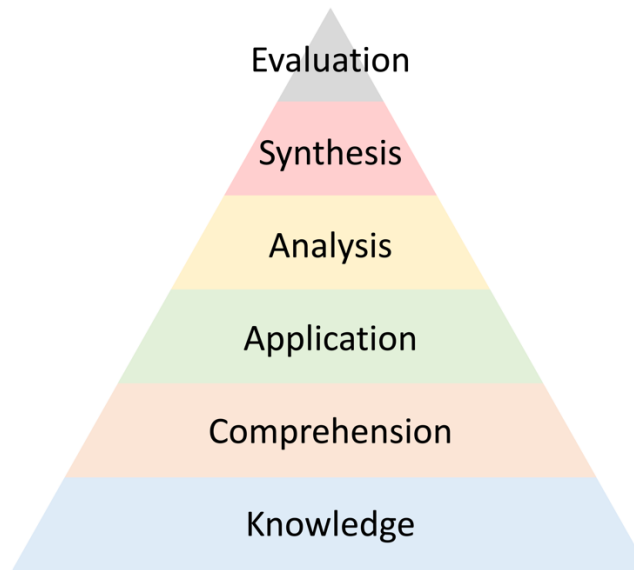
structure used in disaster management (Barnett et al., 2005). Healthcare providers who work at different organisations have their own command structures during ordinary times. However, in DMAT work, they need to work with unfamiliar people under an unfamiliar structure. Therefore, it is vital for DMAT members to have training opportunities to learn and practice the command structure. Previous reports have confirmed the necessity of command structure education based on previous disaster management experiences (Barnett et al., 2005; Crichton and Flin, 2001).

Traditionally, education in disaster medicine has been taught using lectures and/or disaster exercises (Hu, Liu and Li, 2020). However, passive education, such as classical formal lectures, may have some disadvantages in transferring knowledge (Karbownik et al., 2016). Although lectures require less funding and fewer teaching resources, they are often less stimulating and more abstract, which may jeopardise learners' intellectual interest in the subject and might extinguish learners' desire to pursue their study in the targeted subject matter (Hu, Liu and Li, 2020; Beigzadeh and Rahimi, 2015). Furthermore, traditional lectures may not reflect the levels of complexity of practical applications or real-life situations, such as disasters (Bochennek et al., 2007). Disaster exercises are another common method of training and education for disaster medicine, especially for incident command (Crichton and Flin, 2001). Unlike lectures, disaster exercises may be a good method to help learners gain knowledge or skills. Tabletop exercises have been used to teach ICS effectively and at a low cost (Sena et al., 2021); however, learners may not feel the reality of the disaster or lack engagement in the disaster response in this type of exercise (Knight et al., 2010). By contrast, full-scale exercises can create an environment close to disaster but may require considerable funding and a large amount of educational resources (Hu, Liu and Li, 2020). It is also difficult for learners to understand the concept of ICS while participating in a full-scale exercise because they may not be able to see the whole picture in this type of exercise.

The aim of education is to shape human behaviour (Moradian and Mehraein, 2019), which in our case refers to understanding and applying ICS. Behavioural changes may result from a change in perceptions and experiences or both simultaneously (Kang et al., 2013). The education method is an important factor in internalising knowledge and directing it towards correct behaviour (Moradian and Mehraein, 2019). Therefore, appropriate educational approaches should be chosen to obtain the most efficient results (Kang et al., 2013). To shift learners from being recipients of passive knowledge to becoming active and motivated participants, an educational approach that is different from traditional methods should be chosen. The approach should require participation, develop interaction between learners, promote the integration and application of knowledge, and generate motivation, which are basic features of games (Achatz et al., 2020). As previous literature has previously suggested games as an education tool with promising results (Yoon et al., 2014; Kang et al., 2013; Moradian and Mehraein, 2019), and the nature of ICS in the application of disaster management requires a flexible core command mechanism to drive incident response (Kohn et al., 2010), we used games as the method for ICS education.

In our investigation, the lecture group participants were taught about ICS concepts and their applications in DMAT work, while the board-game group participants learned through applying the ICS concepts in a game without receiving a lecture. This may be a vital factor in the effect of our ICS board game. Bloom's Taxonomy, a hierarchical model used for classification of educational learning objectives, describes different levels of learning, from basic to complex. There are 6 levels: knowledge, comprehension, application, analysis, synthesis, and evaluation (Figure 5). Each level builds on the previous level from basic recognition of information to resolving controversies. The application represents the third level of Bloom's taxonomy, which typically requires previous knowledge (Chittum et al., 1996). However, in our study, the knowledge and comprehension levels of Bloom's taxonomy may be completed through the direct application of ICS concepts during the game play. Therefore, participants learned how to apply ICS to disaster rescue in the game and can further apply it to DMAT work.

The game mechanism is also a key factor in transferring knowledge to players (Bochennek et al., 2007). The ICS is a command structure, and its value lies in its use for incident management. An important part of learning ICS is how to apply it to a team or task. Unlike in other educational games where questioning and answering are used, the participants in our game were required to play certain roles and apply what we wanted them to learn. For example, one of the game participants fulfilled the role of incident commander and led the team in a game that simulated a disaster scene. This role-playing mechanism likely contributed to the learning effect of our game (Barnett et al., 2005).



**Figure 5:** Six levels of Bloom's Taxonomy.

A unique feature of the ICS application is that it requires multiple participants to use it, which suits the concept of teamwork. Compared with traditional lectures, board games are a useful tool for promoting teamwork (Yoon et al., 2014). Through teamwork in the game, participants can gain knowledge and promote collaboration (Bangalee et al., 2021), especially in simulation games with reality-based scenarios and action-oriented activities (Vlachopoulos et al., 2017). Teamwork is vital to DMAT operations because team members also need to work together in teams. Additionally, DMAT trainees may actually form a team in the future if a disaster occurs (Bangalee et al., 2021). Educational games that involve teams can promote teamwork and collaboration and simulate real work problems (Akl et al., 2013).

To ensure that DMAT members are ready to work, both novice and experienced members need to attend regular training. Using board games as an educational intervention, novice learners can gain their knowledge from other experienced DMAT members while playing the game as a team (Bangalee et al., 2021). Interaction and cooperation with other game participants may promote active learning (Vlachopoulos et al., 2017; Bochennek et al., 2007). This interaction of game-based learning can engage learners more effectively than lectures (Hu, Liu and Li, 2020).

Another commonly used educational tool for disaster training is disaster exercises. Compared with the reality, fidelity and validity that disaster exercises represent, educational games can provide learners with a positive, pleasant and relaxing learning and practicing environment (Whittam and Chow, 2017; Ma et al., 2021; Beigzadeh and Rahimi, 2015). In this risk-free environment, decision-making and problem-solving learning can be achieved (Karbownik et al., 2016; Charlier and De Fraine, 2013). Moreover, as there are different sections and branches in ICS, the participants can assume one of these roles while learning and practicing ICS. The environment created by our board game included 15 to 25 participants in one room, which allowed participants to see what other roles were doing. In this way, the game participants can learn the whole picture of the ICS more thoroughly than if they were to learn during a full-scale disaster exercise.

Because disasters do not usually happen frequently, many learners may lose their skills or knowledge due to a lack of exposure or practice (Sena et al., 2021). Therefore, disaster training should be repeated at regular intervals to prepare responders for unexpected events. However, while traditional lectures and disaster exercises require instructors, facilitators and/or evaluators, educational games require minimal or even no direction from the facilitator (Sena et al., 2021). Learners can repeat the games many times, allowing players to learn from the experience through the game mechanism of scoring (Charlier and De Fraine, 2013).

Some studies have applied games for education on disasters with good results, but most of them have used digital games (Moradian and Mehraein, 2019). We chose board games to teach ICS for several reasons. First, the development and application of digital games require a high cost that is burdensome for many DMATs (Ma et al., 2021). Second, board games like ours can be easily adapted without the need for programming knowledge

(Charlier and De Fraine, 2013). Finally, the success of disaster management depends on responders' cooperation and communication. The board game used in our study enabled up to 25 participants the chance to cooperate and communicate with each other face-to-face, instead of with computer monitors. Such a setup mirrors a real disaster response, what is used in ICS and what we wanted our participants to learn.

## 5. Limitations

Our study has several limitations. First, our study design was a cohort study instead of a randomised control study, and the age distribution of both groups was different. The sample of the participants was not random, which may have caused some degree of selection bias.

Second, we did not evaluate the effectiveness of long-term knowledge retention. Our study results showed no difference between the lecture and board-game groups based on the tests that were conducted immediately after the lecture and game. However, some research has reported that games did not significantly surpass lecture-based education in the immediate cognitive post-test but exerted its effect on knowledge retention (Karbownik et al., 2016; Hu, Liu and Li, 2020). Longer and repeated follow-ups may reveal different outcomes, and future research should consider the long-term knowledge, skills and affective levels of learners.

Third, there was no evaluation of learners' subjective feeling. The fun of games makes them enjoyable and encourages knowledge acquisition and retention (Hu, Liu and Li, 2020). However, we did not investigate whether the game participants found it interesting, what they thought were the possible knowledge-improving factors or whether they had any suggestions to improve the game. Future studies could explore these subjective factors to identify the advantages and disadvantages of game-based learning.

As in many studies, the board game in our study was conducted by the instructor. Although the instructor did not give a lecture during the game, there was no evaluation of the learning effect in the environment without the instructor. By acting in a facilitating and supporting role, instructors can foster learning, particularly by discussing new information (Vlachopoulos et al., 2017). The pure effectiveness of educational games should be evaluated in the absence of a teacher or instructor.

## 6. Conclusion

This ICS game is the first board game in the field of ICS education. Comparing the learning results, we found that the board-game group's application of ICS improved immediately after the game. Our study thus suggests that a board game based on ICS concepts is an effective pedagogical method and can be used alone as a primary tool for novice trainees. The ICS board game can also serve as an initial tool for people who want to learn about ICS. Using board games in disaster medicine education is highly promising and should be further explored in other areas of disaster medicine.

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