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The Quantitative Evaluation Method of Individual Disaster Management Ability for Goal Setting and Achievement Confirmation of Disaster Prevention Education and Training

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Abstract: It is a well-known fact that education and training are essential for disaster management. However, citizens and companies need to engage in training in addition to their main duties, and there are some situations in which they only conduct statutory fire drills twice a year, which is the minimum required by the Fire Service Act. In this study, we developed a method to quantitative evaluation of individual disaster management as a criterion for indicating the desirable level of education and training (Disaster Management Levelling System: DMLS) and to numerically indicate the achievement target. An ABC evaluation was conducted using the following six contents: 1) Occupational evaluation, 2) Education and training evaluation, 3) Practical evaluation, 4) Experience of Disaster response as work, 5) Experience as a disaster response volunteer, and 6) Hobby evaluation. For quantification, three patterns were examined: pattern 1; Added one point at each ABC rating, pattern 2; Added power of two at each ABC rating, and pattern 3; Added power of three at each ABC rating. The pattern of added power of three at each ABC rating was the most appropriate for the numerical expression. The DMLS is expected not only to set clear goals for disaster prevention education, but also to motivate individuals to engage in education and training through quantitative visualization of educational outcomes.

Keywords: Disaster Education and Training, Quantitative Evaluation Method, Individual Disaster Management Ability, Disaster Management Levelling System (DMLS), Disaster Management, Levelling System

1. Introduction

Similarly, if there are no active or dormant volcanoes, there will be no eruption disasters, and if there are no coasts, there will be no tsunami or storm surge disasters. On the other hand, Article 2, paragraph 1 of the Basic Act on Disaster Management defines a disaster as " the term "disaster" means damage resulting from a storm, tornado, heavy rainfall, heavy snowfall, flood, slope failure, mudflow, high tide, earthquake, tsunami, eruption, landslide, or other abnormal natural phenomena, or a large fire or explosion or other causes provided for by Cabinet Order and similar to the above in the extent of damage they cause". As shown in the examples in this definition, any kind of disasters can be occurred in Japan. As explained by Oishi and Kawashima [1] well known among disaster experts that such disasters occur frequently.

In Japan, the citizens are expected to play a role in limiting the spread of damage from disasters that may occur in the future [2], Article 8 and 36 of the Fire Service Act, which refers to fire prevention managers, and Article 2-2, Paragraph 2 of the Disaster Countermeasures Basic Act, which defines self-reliant and cooperation with others.

For example, the statutory training stipulated in Article 3, Paragraph 10 of the Fire Service Law Enforcement Order

based on Article 8 of the Fire Service Law, which requires facilities above a certain size to conduct disaster preparedness training twice a year. However, the provisions of Article 8 of the Fire Service Law stipulate the minimum necessary obligations [2]. If those trainings are not continued, the acquired skills will become rusty.

In fact, the U.S. military and law enforcement agencies have identified a half-life of six months for the technology and require re-training in marksmanship every six months [4].

Thus, there are not a few cases where further training is found necessary and additional training is conducted against the minimum required training twice a year, or once every six months on average. Masuzawa [5] introduces the education and training in a regional unit called the Shinjuku Station West Exit area. Sakai and Mori [6] describe a company's proactive approach to disaster prevention. As in military organizations, "amateurs focus on hardware (equipment), but deaf people focus on software (training and mental attitude), [7] training is indispensable to cope with damage and prevent its spread.

However, as Oizumi [8] points out, Japanese people culturally lack a sense of crisis. As an actual phenomenon, Iwai [9] argues that even in disaster-affected areas, subsequent disaster preparedness differs depending on the extent of damage. Kanai and Katada [10] major disaster on residents in non-affected areas may last up to two years after the disaster strikes.

In this way, although the necessity of training is recognized, the current situation of education and training for disaster prevention in Japan is that there is a cultural lack of crisis awareness. Under such circumstances, the starting point of this paper is the view that a method other than the arousal of crisis awareness should be sought to enlighten education and training.

2. Point of View: Trial of Quantitative Evaluation of Disaster Management in Hyperacute Phase

2.1. Significance of Quantitative Evaluation of Individuals

The focus of this study is to seek a quantitative evaluation standard that can be consistently used in education and training related to disaster prevention. The second author of this paper has trained more than 10,000 trainees in planning and teaching disaster prevention education and training for companies. In his experience, from the viewpoint of encouraging the continuation of education and training, in the evaluation after their own education and training, the specific evaluation of each person as well as the review of the entire group of trainees has been emphasized.

In the field of education, active learning has been attracting attention in recent years [11]. The new courses of study published by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in 2009 focus on the improvement of classes that incorporate active learning, which is an educational method characterized by independent and interactive learning.

Clarifying the criteria for success and quantitative evaluation are important components of active learning [12]. In addition, Mitsunami [13] has found that quantitative evaluation is more effective in promoting learning behavior when it focuses on personal improvement, learning progress, and mastery rather than comparison with others.

2.2. Narrowing Down the Target Behavior

In this study, the authors will address the Quantitative Evaluation of disaster response ability in the hyperacute phase [14] (within 72 hours after the disaster occurred), which the authors have consistently addressed in their education and training on disaster preparedness and management, especially in the medical field.

The hyperacute phase of a disaster is a time when there are many injured and sick people and the resulting burden on medical institutions is extremely high [15].

Therefore, it is the subject of the author's education and training on disaster prevention for the citizens, even non-medical personnel, should acquire disaster prevention skills to survive the hyper-acute phase of a disaster safely, which will contribute to reducing the number of injured and sick people, reducing the burden on medical institutions, and thus increasing the number of lives that can be saved.

According to Article 2, Paragraph 2 of the Basic Act on Disaster Management, disaster management refers to "preventing a disaster preemptively, preventing expansion of damage after a disaster has occurred, and recovering from a disaster". However, these three stages are not always chronologically ordered. In metropolitan areas, for example, there [16] are cases where preliminary reconstruction efforts are being undertaken in preparation for a future earthquake. In other words, the term "disaster management" has a wide range of applications, and the restoration of breached levees can be seen to prevent future disasters. Considering this situation, we have decided to limit education and training related to disaster prevention in this paper to the hyper-acute phase of a disaster.

2.3. Purpose of Quantitative Evaluation

There are many different types of disasters, and even if past catastrophes are used as examples, they are only examples under specific conditions, which may lead to a biased image in the minds of students [17]. It is true that quantitative evaluations that focus on specific knowledge and skills may lack versatility.

Therefore, we considered the possibility of assessing not only the learning and practical experience of those who act in the event of a disaster (activities include not only proactive activities such as rescue activities, but also activities for one's own survival to avert immediate danger), but also one's own

safety knowledge and skills, assuming them as one of the criteria for quantitative evaluation.

Ensuring one's own safety should always be a priority in disaster operations. The Incident Command System (ICS) is a comprehensive emergency coordination system that was developed in the United States and is now being adopted in other countries [18]. In this ICS, a Safety Officer is assigned as one of the assistants directly un-der the field commander [19]. In the training that assumes that the safety officer will act as a rescuer in the situation response activities, the trainee is made aware that the primary priority is to ensure his or her own safety [20].

In addition, even at sites where the best safety measures are required, such as nu-clear power plants, it has been confirmed that evoking safety-related topics is an important factor in influencing safety confirmation behavior [21].

Thus, especially in the process of acquiring the knowledge and skills required for hyperacute disaster response activities, ensuring one's own safety is an extremely important theme. Therefore, we hypothesized that knowledge, skills, and experiences that are not directly or explicitly related to disaster response should be included in the evaluation as abilities that contribute to disaster response in areas where safety management is required.

3. Develop Disaster Response Ability Standards

In this paper, the Disaster Management Levelling System (DMLS) was used to evaluate the following six criteria: 1) Occupational evaluation, 2) Education and training evaluation, 3) Practical evaluation, 4) Experience of Disaster response as work, 5) Experience as a disaster response volunteer, and 6) Hobby evaluation. The DMLS firstly each evaluation items with an ABC rating (including AA in some categories) was conducted, and the results were converted into numerical values. For the numerical conversion, three scoring patterns were created: pattern 1; 1; Added one point at each ABC rating (C: 1 point, B: 2 points, A: 3 points, AA: 4 points), pattern 2; Added power of two at each ABC rating, (C: 1 point, B: 2 points, A: 4 points, AA: 8 points), and pattern 3; Added power of three at each ABC rating (C: 1 point, B: 3 points, A: 9 points, AA: 81 points).

3.1. Occupational Evaluation (Table 1)

Some occupations are directly related to the safety of one's own or others' body or life. It is assumed that the knowledge and skills learned in the education and training can be applied to the evaluation of disaster response capability. In addition, it was assumed that the work experience of the relevant job itself would contribute to disaster response. The classification of occupations is based on the occupational classification used in the "Labor Force Survey 2008" of the Statistics Bureau of the Ministry of Internal Affairs and Communications.

Table 1. *Occupational evaluation criteria.*

Level	Criteria
C	Occupations that are engaged in an environment where they come into contact with an unspecified number of users at facilities, etc., and that do not fall under the content of a B rating or higher.
B	Occupations that receive safety-related education and training in the relevant occupational area, mainly for their own safety, such as special education based on the Industrial Safety and Health Law.
A	Occupations that involve the life or physical safety of a third party

3.2. Education and Training Evaluation (Table 2)

Education and training related to disaster response is classified according to its pedagogy. In so-called active learning, which encourages learners to learn continuously and autonomously, learning outcomes are intangible unless they are recorded and evaluated, and are not considered to be evidence of learning that can be shared with others [22] hence, the degree of evaluation content was adopted for the classification of pedagogy.

Table 2. *Education and Training Evaluation Criteria.*

Level	Criteria
C	Those that allow students to experience educational content through methods such as reading, viewing, and practical skills
B	A process of education and training that provides opportunities for learners to voluntarily experience failure, misuse, and misunderstanding, and in which failure and correct answers are clearly displayed.
A	where the outcomes of education and training are quantitatively assessed by fair and equitable criteria and the results are provided to the individual

3.3. Practical Evaluation (Table 3)

As the English idiom, "When it comes to learning something, nothing beats practice". Therefore, it is assumed that the experience in the learner's current occupation, which contributes to disaster response, can also be used for disaster response ability evaluation.

Table 3. *Practical Evaluation Criteria.*

Level	Criteria
C	A practical experience (evaluation for each occupation)
B	Multiple practical experiences (evaluation for occupation)

3.4. Experience of Disaster Response as Work

Among the practical experience, the experience of disaster response as a duty work to be evaluated for disaster management ability. Since it is a job-related experience, one disaster experience as duty was considered as AA evaluation.

3.5. Experience as A Disaster Response Volunteer

Of the practical experience, the experience as a disaster response volunteer deserves an evaluation of disaster response capability. One disaster response activity more than 3 days was given an A rating because it was done as a volunteer.

3.6. Hobby Evaluation

In the field of hobbies, not only scuba diving, which requires a license, but also mountain climbing and other outdoor sports, it will come close to hazards that may affect one's own life. It is assumed that the knowledge and skills acquired to avoid such problems can be used for disaster response ability evaluation. Those with more than three years of experience were given an A rating.

4. Verification of DMLS

4.1. Target and Method

A questionnaire survey was conducted from September 15 to September 30, 2021 to validate the quantification of the DMLS. The subjects of the survey were males and females aged 20 years or older. The outline of the study and the purpose of the study were described in the web questionnaire, and only those who consented to the study were allowed to send responses. This study was approved by the Ethical Review Committee of Kokushikan University (No. 21016). The data were analyzed using Microsoft ®Excel® for Mac and SAS JMP ®Pro version 15. The basic data were simply tabulated, and for the DMLS, each evaluation item was quantified using three types of scoring patterns: pattern 1, pattern 2, and pattern 3. For the DMLS, each evaluation item was numerically scored in three patterns: pattern 1, pattern 2, and pattern 3. In addition, mean values were calculated for occupation specific scores, nonparametric multiple comparisons were conducted, and a Steel test was conducted with the others as the control group. In addition, Pearson's χ 2test was conducted to compare the scores (in digits) by occupation. The significance level was set at $p<0.001$. Three patterns of inconsistency in the comparison of scores were extracted and examined, and the most appropriate pattern of score allocation was selected.

4.2. Survey Contents

The survey included gender, age (20s, 30s, 40s, 50s, 60s, 70s or older), current occupation, past occupation (occupation engaged in for more than one year), disaster drills participated in (content and number of times), experience of emergency response actions (first aid, transport, reporting) and number of the experiences (one or more times), experience of disaster response as work (disaster name), experience of disaster response as a volunteer (more than three days), and outdoor sports experience (more than three years of experience).

4.3. Survey Results

4.3.1. Basic Data

The survey included 153 valid respondents by gender. 75 males (49.0%) and 78 females (51.0%). The percentages by age were 24 (15.7%) in their 20s, 54 (35.3%) in their 30s, 46 (30.1%) in their 40s, 25 (16.3%) in their 50s, 2 (1.3%) in their 60s, and 2 (1.3%) in their 70s or older. The distribution of occupations was as follows: 28 (18.3%) in Security position, 43 (28.1%) in Profession, 62 (40.5%) in Clerical position, and 20 (13.1%) in Others (freelance work/housewife, etc.; control group).

As for the disaster drills in which they participated, since the respondents did not provide detailed information on the drills, all of them were given a grade of "C" and added up according to the number of times they participated (multiple or many similar notations were considered as two times).

4.3.2. Pattern 1; Added One Point at Each ABC Rating (C: 1 Point, B: 2 Points, A: 3 Points, AA: 4 Points)

When the ABC ratings were quantified by scoring one point each, the overall score was a maximum of 53 points, a median of 9 points, a minimum of 0 points, a mean of 11.81 points, and a standard deviation of 11.43 points. The distribution of the overall scores (in increments of 5 points) is shown in Figure 1.

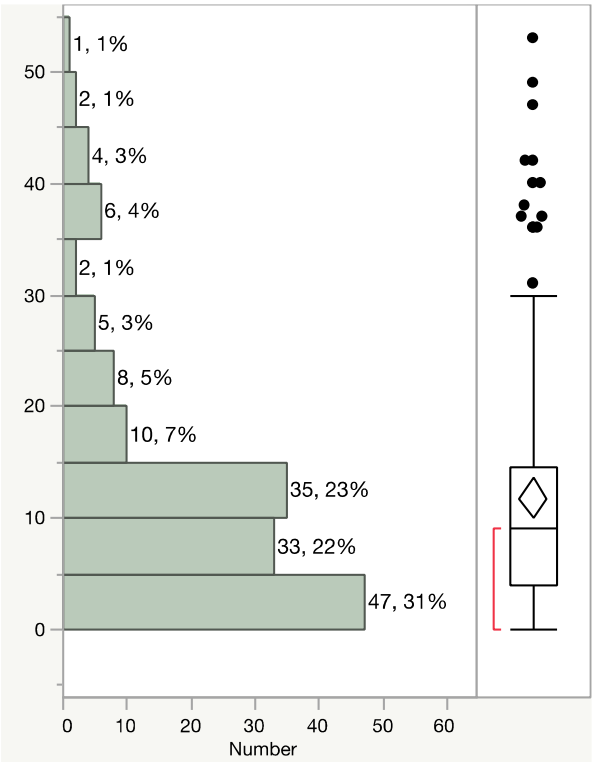

Figure 1. *Score distribution of Pattern 1 (5-point increments).*

The occupational scores of Professions (43 persons) were 42 points for the maximum, 10 points for the median, 1 point for the minimum, 12.44 points for the mean, and 9.20 points for the standard deviation. The maximum score for Clerical Positions (62) was 53, the median was 5.0, the minimum was 0, the mean was 9.24, and the standard deviation was 10.84. Security Positions (28 persons) had a maximum value of 49 points, a median value of 15.5 points, a minimum value of 5 points, a mean value of 20.46 points, and a standard deviation of 12.94 points. Others (20 students) had a maximum value of 36 points, a median value of 3.0 points, a minimum value of 0 points, a mean value of 6.30 points, and a standard deviation of 8.80 (Figure 2).

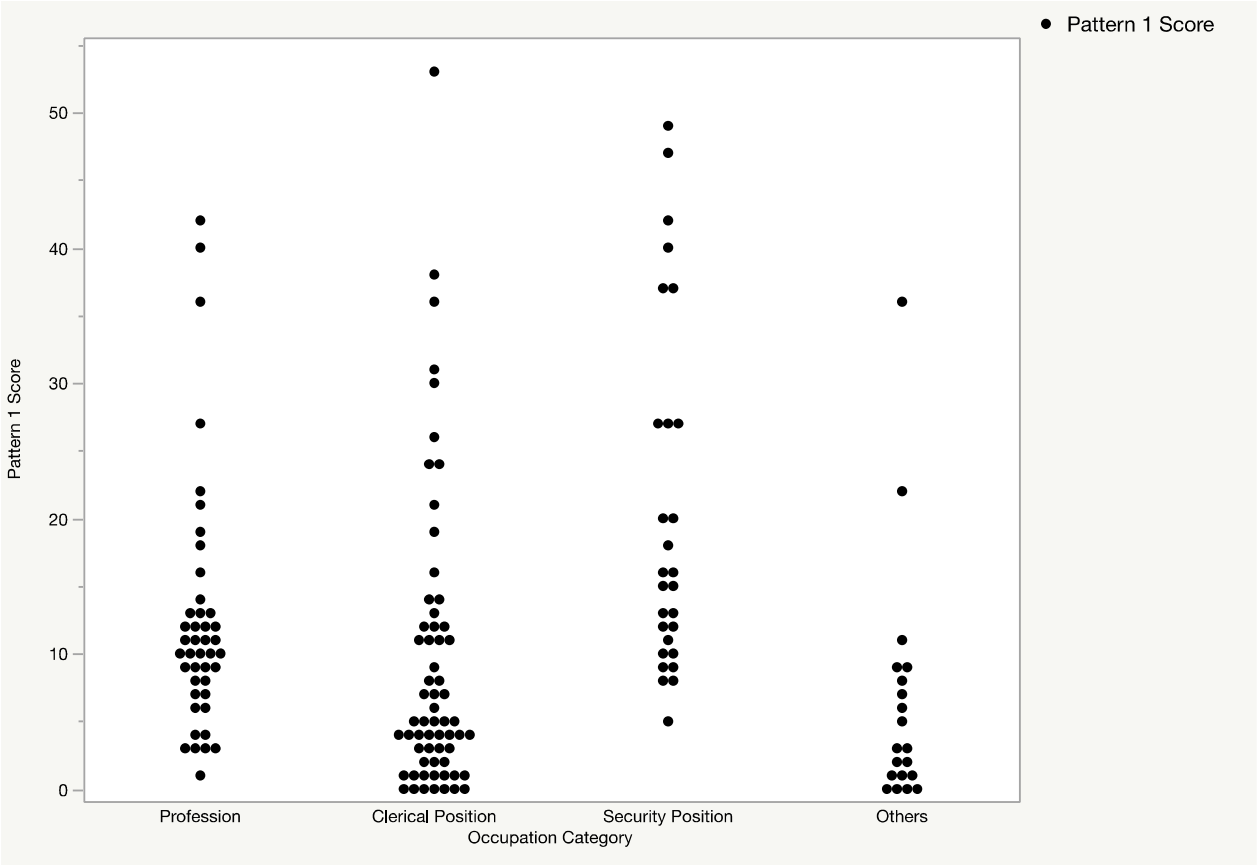

Figure 2. *Pattern 1: Score distribution by occupation.*

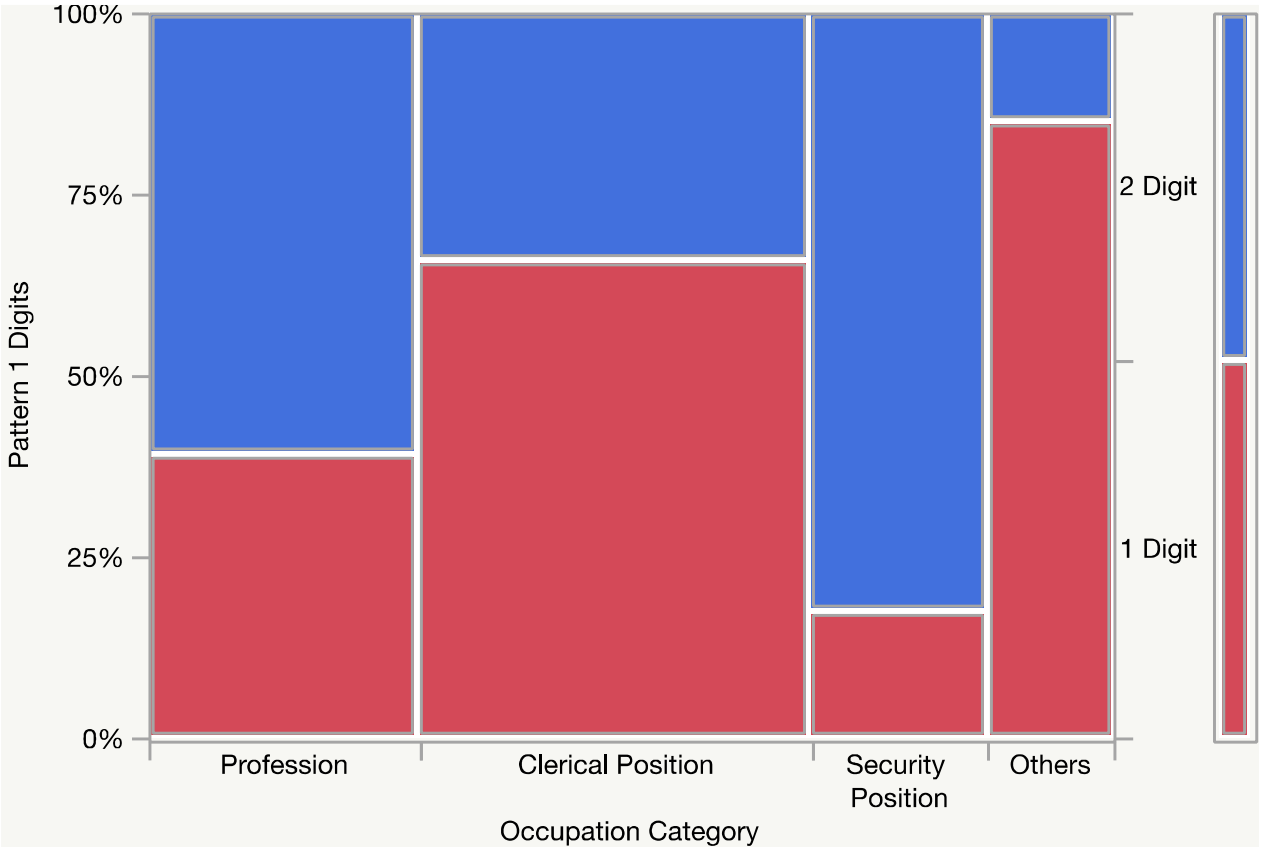

Figure 3. *Pattern 1: Distribution of scores by occupation (Digits).*

Comparing the mean of each occupation's score with the control group (others), the Profession ($p=0.0006$) and Security Position ($p<0.001$) were significantly higher, while no difference was found in the Clerical Position. About comparing the scores by occupation (in digits), Profession had 17 (39.53%) in single digits and 26 (60.47%) in double digits. For Clerical Position, 41 (66.13%) were in single digits and 21 (33.87%) were in double digits. Security Position had 5 single digit (17.86%) and 23 double digit (82.14%). Others were 17 (85.00%) in single digits and 3 (15.00%) in double digits, showing a significant difference ($p<0.001$) (Figure 3).

4.3.3 Pattern 2; Added Power of Two at Each ABC Rating (C: 1 Point, B: 2 Points, A: 4 Points, AA: 8 Points)

When the ABC ratings were quantified to the power of two, the overall score was a maximum of 110, a median of 11, a minimum of 0, a mean of 19.72, and a standard deviation of 22.56. The distribution of the overall scores (in increments of 5 points) is shown in Figure 4.

About the scores od each occupation, for Profession was maximum 77, median 12, minimum 1, mean 17.56, and standard deviation 16.06. Clerical Position had a maximum value of 73 points, a median of 6.0 points, a minimum of 0 points, a mean of 12.69 points, and a standard deviation of 16.10. Security Position had a maximum value of 110 points, a median value of 39.5 points, a minimum value of 17 points, a mean value of 48.00 points, and a standard deviation of 27.26 points. Others had a maximum value of 36 points, a median value of 3.5 points, a minimum value of 0 points, a mean value of 6.55 points, and a standard deviation of 8.88 (Figure 5).

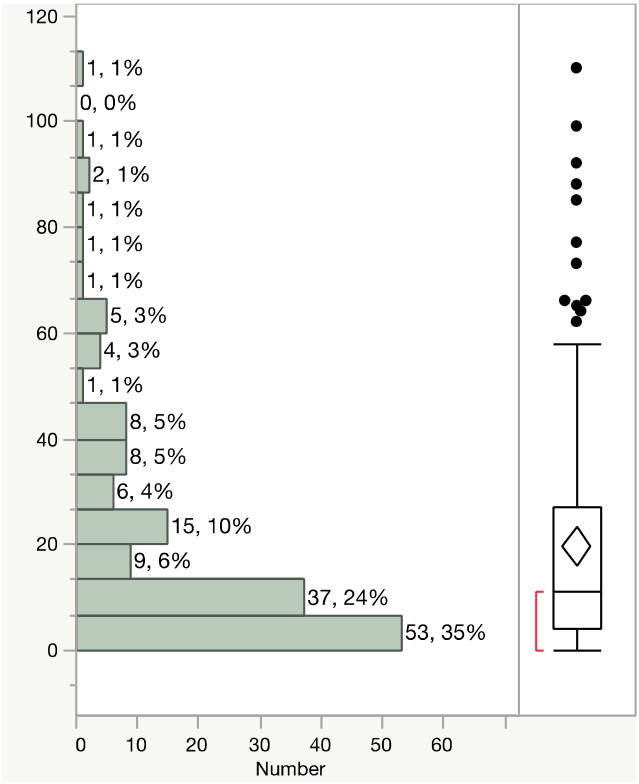

Figure 4. *Score distribution of Pattern 2 (5-point increments).*

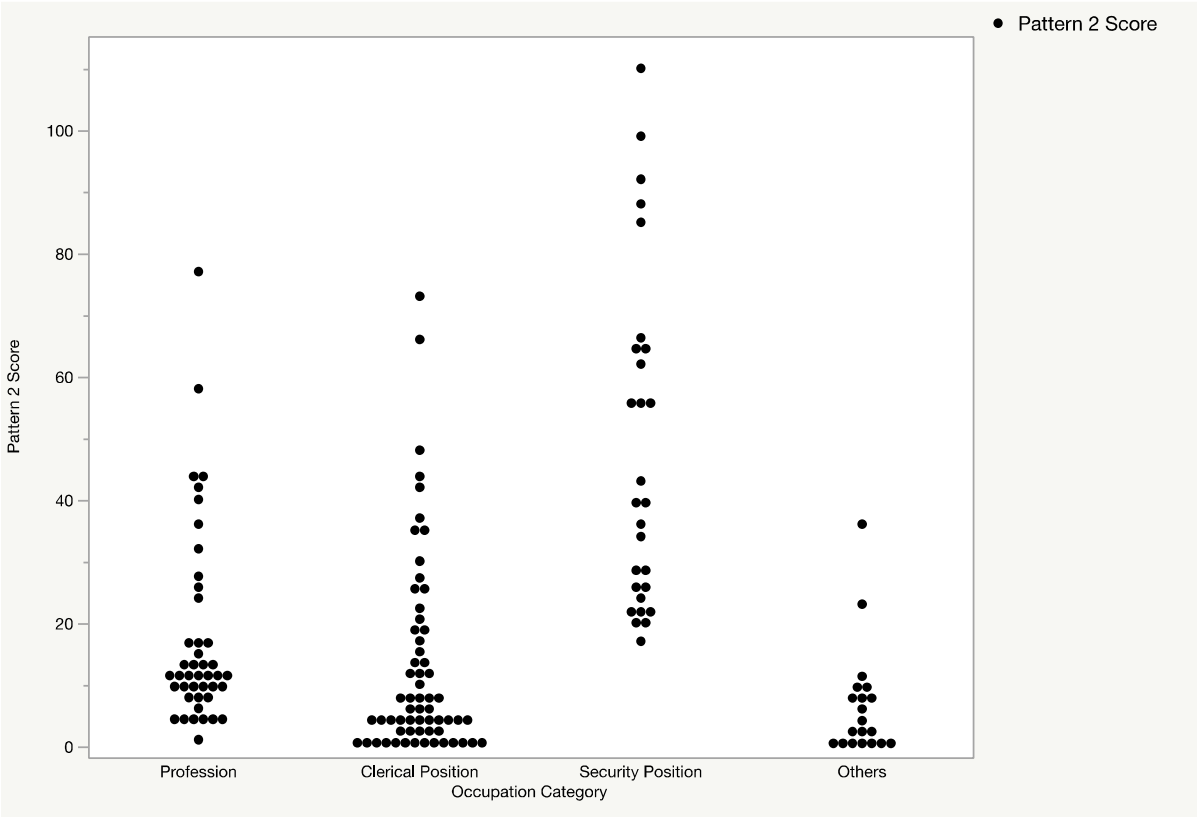

Figure 5. *Pattern 2: Score distribution by occupation.*

Comparing the mean of each occupation's score with the control group (others), the Profession (p=0.0002) and Security Position (p<0.001) were significantly higher, while no difference was found in the Clerical Position.

About comparing the scores of each occupation (in digits), Profession had 14 (32.56%) in single digits and 29 (67.44%) in double digits. Clerical Position had 38 (61.29%) single digits and 24 (38.71%) double digits. Security occupations had 0 (0.00%) in single digits, 27 (96.43%) in double digits, and 1 (3.57%) in triple digits. Others were 17 (85.00%) in 1-digit and 3 (15.00%) in 2-digit, showing a significant difference (p<0.001) (Figure 6).

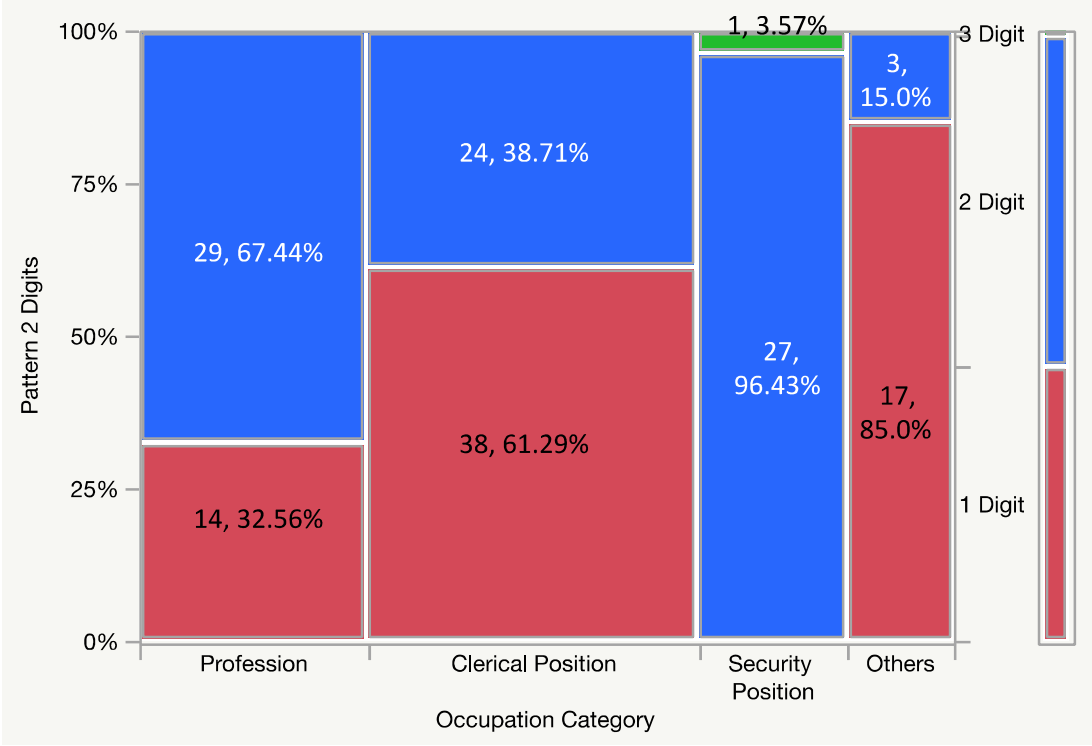

Figure 6. *Pattern 2: Distribution of scores by occupation (Digits).*

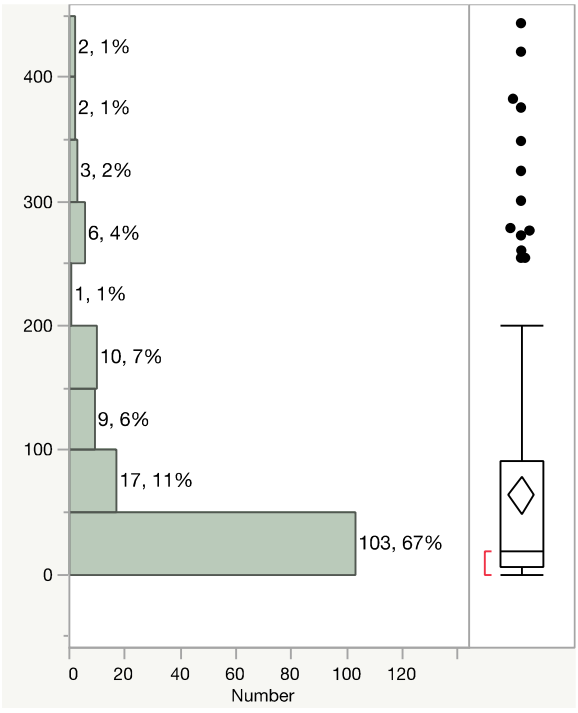

Figure 7. *Score distribution of Pattern 3 (50-point increments).*

4.3.4. Pattern 3; Added Power of Three at Each ABC Rating (C: 1 Point, B: 3 Points, A: 9 Points, AA: 81 Points)

When the ABC ratings were quantified to the power of 3, the overall score was 443 (maximum), 18 (median), 0 (minimum), 63.63 (mean), and 95.29 (standard deviation). The distribution of the overall scores (in increments of 50 points) is shown in Figure 7.

The score of Profession was maximum 300 points, median 19 points, minimum 1 point, mean 46.70 points and standard deviation 66.80. Clerical Position had a maximum value of 276 points, a median of 9.5 points, a minimum of 0 points, a mean of 32.21 points, and a standard deviation of 55.14. Security Position had a maximum value of 443 points, a median of 169.5 points, a minimum of 82 points, a mean of 198.68 points, and a standard deviation of 115.49. Others had a maximum value of 37 points, a median value of 6.5 points, a minimum value of 0 points, a mean value of 8.35 points, and a standard deviation of 9.99 (Figure 8).

Comparing the mean of each occupation's score with the control group (others), the Profession (p<0.001) and Security Position (p<0.001) were significantly higher, while no difference was found in the Clerical Position.

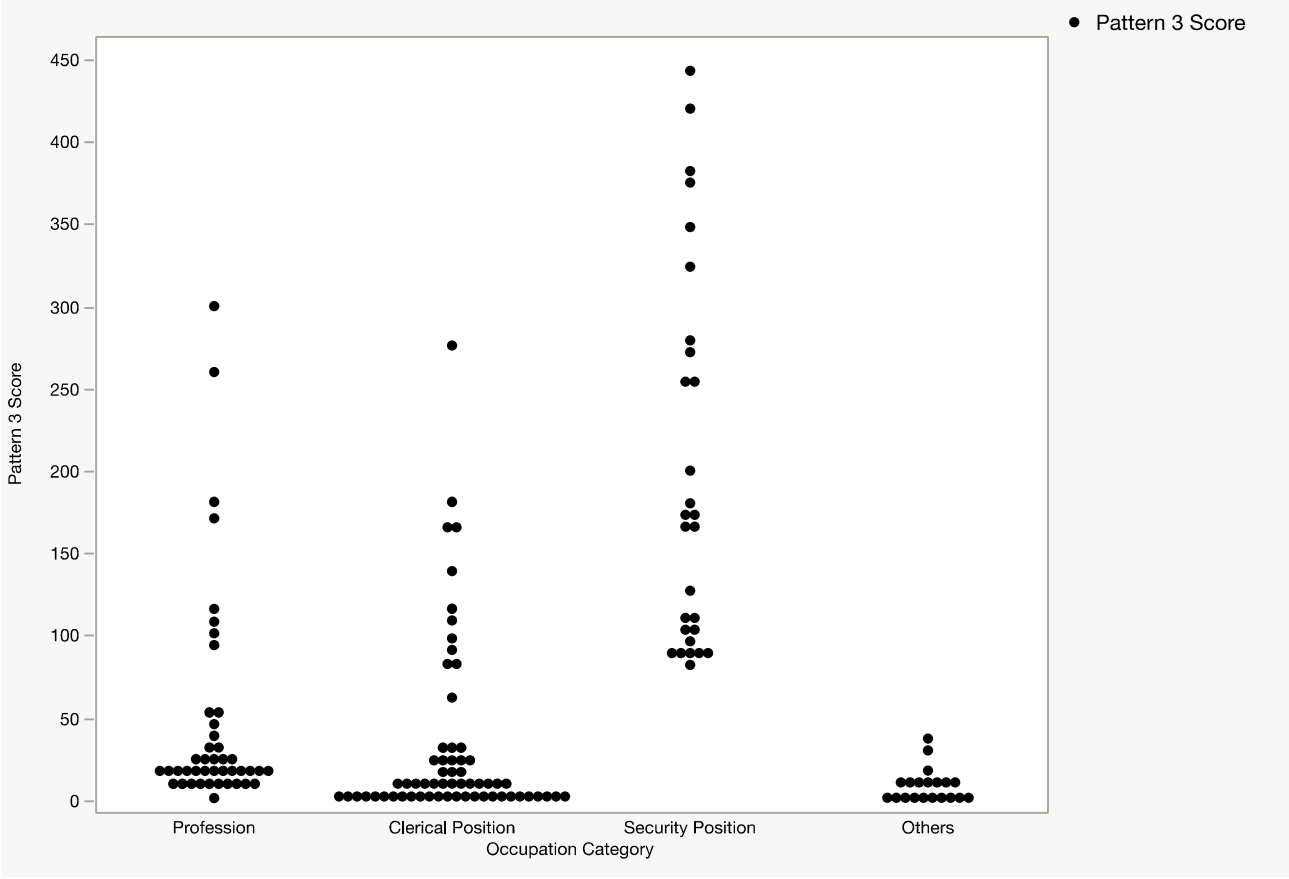

Figure 8. *Pattern 3: Score distribution by occupation.*

About comparing the scores by occupations (in digits), Profession had 7 (16.28%) single digit, 30 (69.77%) double digit, 6 (13.95%) triple digit and 2 (4.65%) of the triple digit scored 200 or above. For Clerical Position, 31 (50.00%) were in single digits, 24 (38.71%) were in double digits, 7 (11.29%) were in triple digits, and 1 (1.61%) was in triple digits with a score of 200 or higher. Security Position had 0 (0.00%) in single digits, 8 (28.57%) in double digits, 20 (71.43%) in triple digits, and 11 (78.57%) with 200 or more points out of 3 digits. Others showed significant difference in 12 (60.00%) single digit and 8 (40.00%) two digit ($p<0.001$) (Figure 9).

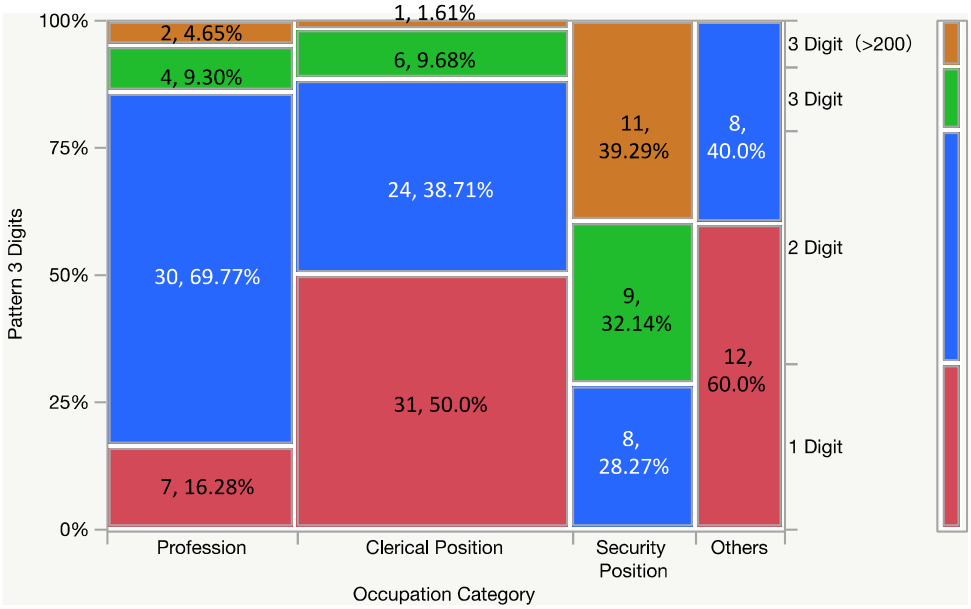

Figure 9. *Pattern 3: Distribution of scores by occupation (Digits).*

4.3.5. Comparison Between the Patterns

The score comparison of the overall score calculated by pattern 1, pattern 2, and pattern 3 are shown in Table 4, and the score (digits) comparison is shown in Figure 10.

Table 4. *Education and Training Evaluation Criteria.*

	Pattern 1	Pattern 2	Pattern 3
Maximum Score	53	110	443
Median	9	11	18
Minimum score	0	0	0
Average	11.81	19.72	63.63
Standard deviation	11.43	22.56	95.29

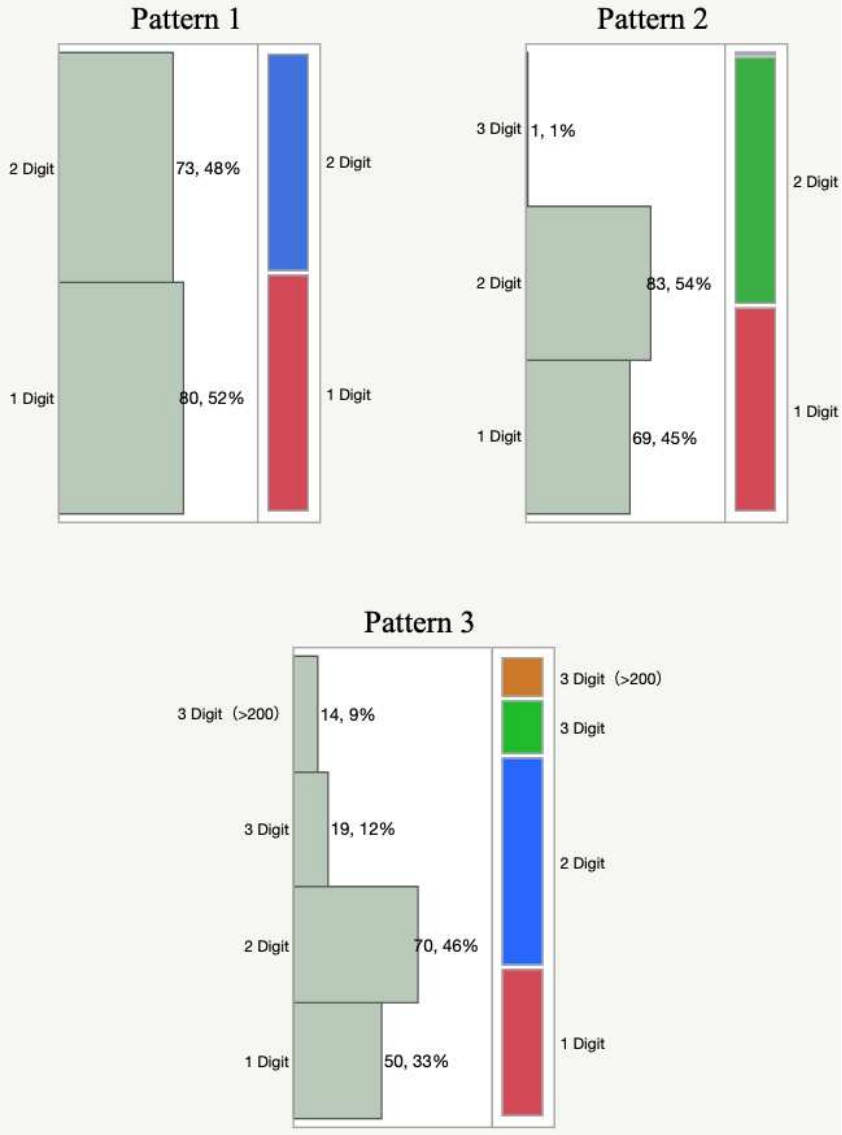

Figure 10. *Comparison of overall score (digits) for each pattern.*

In terms of scores (number of digits), it is clear that the half of the scores in pattern 1 and Pattern 2 are in the one-digit and two-digit categories, whereas the variation appears in pattern 3. We also extracted the top 20 scorers for each of the distribution points (Table 5). Comparing the occupations of the top 20 scorers, in pattern 1, 4 (20.0%) were professions, 6 (30.0%) were clerical positions, 9 (45.0%) were security positions, and 1 (5.0%) was other. In pattern 2, 4 (20.0%) were specialists, 4 (20.0%) were clerical positions, and 12 (60.0%) were security positions, while in pattern 3, 4 (20.0%) were professions, 2 (10.0%) were clerical positions, and 14 (70.0%) were security positions. In Pattern 3, 70% of the top positions were occupied by security positions, while in Pattern 1, 45.0%.

In addition, we compared the ABC ratings and scores for each point distribution for one profession (4th), two clerical positions (1st and 8th) and one security position (2nd), and

one other (11th) that ranked high in pattern 1 (Table 6). The first-ranked clerical position had 1 AA, 1 A, 3 B, and 40 C. The second-ranked security position had 5 A, 1 A, 3 B, and 20 C. The fourth-ranked profession position had 1 A, 2 B, and 35 C; the eighth-ranked clerical position had 4 A and 26 C, and the 11th-ranked other had 1B and 36 C.

Table 5. *Comparison of the top 20 scorers for each pattern.*

Rank*	Pattern 1		Pattern 2		Pattern 3	
1	Clerical position	53	Security Position	110	Security Position	443
2	Security Position	49	Security Position	99	Security Position	420
3	Security Position	47	Security Position	92	Security Position	382
4	Profession	42	Security Position	88	Security Position	375
4	Security Position	42	Security Position	85	Security Position	348
6	Profession	40	Profession	77	Security Position	324
6	Security Position	40	Clerical position	73	Profession	300
8	Clerical position	38	Clerical position	66	Security Position	278
9	Security Position	37	Security Position	66	Clerical position	276
9	Security Position	37	Security Position	65	Security Position	272
11	Profession	36	Security Position	64	Profession	260
11	Clerical position	36	Security Position	62	Security Position	254
11	Others	36	Profession	58	Security Position	254
14	Clerical position	31	Security Position	56	Security Position	200
15	Clerical position	30	Security Position	56	Clerical position	181
16	Profession	27	Security Position	55	Profession	181
16	Security Position	27	Clerical position	48	Security Position	178
16	Security Position	27	Profession	43	Security Position	173
16	Security Position	27	Clerical position	43	Security Position	172
20	Clerical position	26	Profession	43	Profession	171

* Score Rank of Pattern 1.

Table 6. *Comparison of scores of the top 5 scorers in Pattern 1.*

Rank*	Occupation	ABC Ratings				Score by Pattern		
		AA	A	B	C	1	2	3
1	Clerical position	1	1	3	40	53	66	139
2	Security Position	5	1	3	20	49	110	443
4	Profession	0	1	2	35	42	43	50
8	Clerical position	0	4	0	26	38	42	62
11	Others	0	0	1	34	36	36	37

From the result of pattern 1, the relationship between the number of ABC evaluations and the score of the first-ranked clerical position and the second-ranked security worker, the higher the number of C evaluations, the lower the number of AA evaluations, but the higher the score. Similarly, in Pattern 2, when the relationship between the number of ABC evaluations and the scores of the fourth-ranked specialist and eighth-ranked clerical position in Pattern 1 was examined, the higher the number of C evaluations, the higher the score, even though the number of A evaluations was small. Most of these C ratings were found to have been earned through training experience (Table 7).

Table 7. *Comparison of education and training scores of the top 5 scorers in Pattern 1.*

Rank	Occupation	Education and training evaluation (Counts)		
		A	B	C
1	Clerical position	0	0	40
2	Security Position	0	0	20
4	Profession	0	0	34
8	Clerical position	0	0	26
11	Others	0	0	31

The AA evaluation is derived from occupational experience and actual experience based on the occupation. The occupations and jobs that receive the AA evaluation include self-defense officers, firefighters, and police officers. It is reasonable to assume that these people repeat education and training on a daily basis as part of their job and use the results of their education and training in their work. Kusumi [23] describes the skills and knowledge acquired on the job as practical knowledge, which is the basis for their high level of performance. In addition, Ericsson [24] proposes the "10-year rule", which states that it takes about 10 years of practice and experience to acquire a high level of knowledge and skills, and that those who can acquire AA evaluation have abilities that cannot be surpassed by those who have acquired many C evaluations through dozens of times of education and training. It is difficult to say that the AA evaluation is appropriately evaluated in Pattern 1 and Pattern 2. It was judged that pattern 3 appropriately quantifies all ABC evaluations.

5. Discussion

In this study, we developed the DMLS and verified the numerical scores based on the following six items as quantitative evaluation criteria for disaster management: 11) Occupational evaluation, 2) Education and training evaluation, 3) Practical evaluation, 4) Experience of Disaster response as work, 5) Experience as a disaster response volunteer, and 6) Hobby evaluation. The authors believe that the evaluation of safety-related knowledge and skills should be the most important thing of hyperacute disaster operations.

Heather [25] used the Disaster Preparedness Evaluation Tool (DPET) assessed perceived knowledge of disaster preparedness, disaster mitigation and response, and disaster recovery for

military health care personnel and they found the 6 significant variables that predicted DPET scores: 1) previous disaster drills, 2) experiencing a real disaster, 3) bioterrorism training, 4) education level, 5) years in specialty, and 6) previous global health engagement missions. They focused on military personnel, but their results supported our evaluation process.

Looking at the overall scores, there was little variation in the numerical values of Pattern 1 and Pattern 2, while there was some variation in the numerical values of pattern 3. However, there were significant differences in the scores (number of digits) of all the scoring patterns. When top five of scorers in pattern 1 were selected and their individual ABC evaluations and scores were compared, the number of evaluations in Pattern 1 and Pattern 2 had a significant effect on the overall score. It was found that the AA and A ratings could not be quantified appropriately, and only in Pattern 3 could they be quantified without contradiction. Therefore, the authors judged that it was appropriate to use the power of three in pattern 3 (C: 1 point, B: 3 points, A: 9 points, AA: 81 points) for quantification.

In addition, the mean score of the Profession was significantly higher than that of the other occupations in the control group, but their score was lower than that of the Security Position, so they are likely to be able to conduct activities in their respective areas of expertise. However, it is difficult to imagine that Profession (medical personnel, engineers, teachers) will be able to take the initiative in hyper-acute phase. Furthermore, the average score of Clerical position was not significantly different from that of other occupations, suggesting that it would be difficult for them to reach out to others during the hyper-acute phase of a disaster. Therefore, we believe that individual disaster management ability can be improved by continuing education and training in which the results of education and training based on hyper-acute phase activities are quantitatively evaluated by fair and equitable standards and the results are provided to everyone, except for security position.

Although there are various possible methods for measuring the proficiency for each type of skill, the improvement of processing speed with repetition is used as one of the standard indicators [26] because it is universally observed independent of the type of skill. Also, Katayama [27] said that disaster prevention education with weekly exercise significantly increased participants' self-efficacy. It suggested that getting education or training constantly didn't only improve their skill but their motivation to get more education.

In this study, we have not conducted an evaluation of the experience of attending education and training because we had not been able to collect detailed data. In the future, we plan to examine the quality of education and training and the improvement of individual skills through repetition so that they can be reflected in the DMLS as quantitative evaluation criteria.

6. Conclusion

In this study, the DMLS was developed as a quantitative evaluation standard that can be used consistently in education and training related to disaster prevention and management was verified. The power of three is appropriate for the quantification of ABC evaluation using the DMLS. The DMLS can measure the level of disaster response ability from a lay person to professionals like firefighters with a single numerical value. Therefore, the DMLS is expected not only to set clear goals for disaster prevention education, but also to motivate individuals to engage in education and training through quantitative visualization of educational outcomes.

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