

Content Analysis of Engineering Skills Competition in Taiwan

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Abstract

In the ancient Chinese book *Tien Hsiuan Zi*, it is stated that “An average manager can follow the rules, whereas a wise manager can make the rules.....he who succeeds in following the rules is called ‘wise’; he who is succeeds in making the rules is called ‘god’”. Through a scientific analysis of engineering skills competitions, this research aims to help administrators of schools participating in these competitions to devise training strategies. The study was conducted through simultaneous use of the questionnaire survey method and the lateral vector method. The questionnaire developed by the researchers was used to inquire into the current situation regarding training of contestants. The lateral vector method was used to analyze the correlation between various aspects of competitions. The research discovered that among schools that trained contestants, on 48% of these included written testing as part of their overall training program. In addition, written test score a positive causal effect on placement in competitions, which is consistent with t-test results. Through a discussion of results, four main conclusions have been drawn: 1). The higher the score on the written test the greater the influence that it will have on competition placement; 2). 58.33% of the variation in competition placement is influenced by written test scores; 3). Approximately 18% of contestants will place higher due to their scores on written tests; 4). The higher the placement in competitions the greater the influence of written test scores. Finally the researchers proposed that if participating schools want to place high in competitions, they will raise to 18% the portion that written testing makes up of the entire training program.

Key words: content analysis, lateral vector method (LVM), written scores, competition placement

I. Introduction

“Optimization” has become the focus for competitiveness in the 21st century [1]. “Optimization” means the ability to keep progressing and seize competitive advantages. For schools, in order to encourage outstanding students to participate a competition [2], the organizer of the competition has no choice but to include a written test into the competition. According to the statistics of the Manuals of 2010 National Industrial Skills Competition of High School Students, written test of 90% of skills competitions fields takes up 20% of the total grades, making fiercely competed skill competitions even more difficult than before. Hence, it becomes apparently critical for instructors to “identify talented contestants” [3]. Therefore, whether or not including a written test into a competition will influence “the outcome of the overall skill performance” and the extent of the influence is a worth-exploring issue.

II. Literature Review

Only when a competition is competed fairly and evaluated with an objective standard can it achieves the effect of having competitors sharpen skills with one another [4]. “Skills competition” was previously named “technical competition” and is renamed so to enhance the importance of written test. A skills competition is exclusively designed for vocational students. The major goal is to improve students’ practical ability, so that they can enter the workplace more easily and have greater sense of achievement [5]. From the content of a skills competition, it can be roughly divided into skills test and written test. From the entire process which a competitor will go through, it can be categorized into three stages: 1. preparation, 2. competition, and 3. outcome [6]. Factors which are involved in the entire process include the content of competition, training

course, academic performance, practical operation, and mental factor.

1. Analysis of the Content of Skills Competition

The Ministry of Education (MOE) organizes engineering skills competitions to encourage students to value the practical use of skills and stimulate cross-school observation and exchange. In this way, it will also arouse the public awareness of the importance of technicians [7], improve technicians' skills level to meet the need of the economic development of the country [8], and ultimately achieve the goal set by employment of vocational schools. In the 2010 engineering skills competition as an example, there were totally 125 schools and 1,048 students participating in 24 fields of skills competitions [9].

Items in a skills competition are selected from engineering courses taught in the first five semesters of vocational schools. The competition includes a written test and a skills operation which together takes up a day and half to be completed. The entire process is divided into preliminary and final competitions. The preliminary competition is implemented by the competition committees organized by each participant school with competition plans determined based on the model of the final competition. The grades of the final competition are determined in percentage with the scores earned from the written test and the skills operation [9]. The percentage of the scores of the written test and skills operation varies slightly among different vocation fields. Table 1 shows the percentage of the written test and skills operation from the 2008 to 2010 academic years. The statistic shows among the competitions of the 24 vocation fields, the written test / practical operation percentage of most of the vocation fields is 2 to 8 (50% of the vocation fields). Nearly 80% of the vocation fields whose written test takes up 20% in the total grades.

Table 1. Written Test-Practical Operation Ratio 2010 Engineering Skills Competition

Written Test / Skills Operation Ratio	1/9	1.5/8.5	2/8	2.5/7.5	3/7	4/6
Vocation Fields(%)	5(22%)	1(4%)	12(50%)	2(8%)	2(8%)	2(8%)

2. Training Course

Gladwell (2008) proposes the theory of “ten thousand hours.” According to his survey, it takes at least ten thousand hours of practicing to become an expert in any given field, and this is just a basic requirement. Be it athletes, painters, musicians, writers, or even criminals, this number has been proven valid again and again [10]. Applying this theory into skills training, one will find that if s/he practices five hours a day everyday except for national holidays (300 days in total), there are only 1,500 hours of practice a year. There are still six and half years away from the ten thousand hours. In comparison with the content of skills competitions, it is found that long hours of training alone will not guarantee an easy access to good placement [7]. Regarding this, one has to rule out the factor of time and find more effective ways of training.

3. Skills and Academic Performance

Skills performance refers to the external performance after learning. All actions during the learning of skills are manipulated by the learner's body. Therefore, while operating, one can not only manipulate his/her own actions but also perceive the consequences after completing the actions. Such a perception of immediate actions is called feedback function in the theory of learning. To learners, this function creates a new stimulus, and theoretically, this new stimulus triggers another reaction to have the learner correct his/her actions so as to sharpen his/her skills [7].

Academically, vocational students perform poorer than high school ones. Adding written test into skills competitions creates quite a psychological stress to most vocational students. On top of that, written test takes up 20% of the total grades, making most contestants give up the training for written test. This is caused by the stereotype that one can perform well both academically and skillfully. According to Shephard's experimental research, it is possible to do well both [11], but how to do it is the only question that requires the collective efforts of researchers.

In this research, engineering skills competitions are belonging to an individual competition. An individual selects or combines different strategies for competition based on his/her goal. Due to the fact that different vocation fields have different goals, it is difficult to find a common factor for research. Regarding this, this study narrows the scope of research to written test in an attempt to find a better strategy for competition.

4. Mental Analysis

In a fiercely competed competition, after choosing contestants, instructors start to make training programs, adjust competitors' physical and psychological status, and help them to deal with academic pressure [12]. Physical status is expressed eternally and can be detected, whereas psychological status is not easy to be detected [13]. During repeated rehearsals, testing and correcting students' skills performance [14] will help them become more familiar with the operation and improve their skills [15]. Due to the fact that competitors' mental factor will affect their performance during competition, it is particularly important to train contestants' ability to deal with stress in a simulation.

Given the fact that one can benefit from others' knowledge, if theories of sports psychology can be applied to analyze psychological difficulties occurring during competitions, it can help to propose psychological training and method to cope with mental difficulties and help students to overcome doubts, uncertainty, or anxiety. Mental training which can help to eliminate nervousness and ease anxiety include: participating various types of competitions and using stimulations to ease nervousness. Mental training which can help to increase confidence include: participating in pre-game competitions, confidence training, and self-training [16]. There is a variety of pressure caused by different competitions and requires different methods to adjust. However, there is a lack of attention in this regard and needs more research efforts.

III. Methodology

Given the fact that gold medal is the highest regarded prize in skills competitions, this study focuses only on placements that are nearest to the gold medal in each of the vocation fields. This study explores whether or not there is a correlation between written test and placements, which vocation fields are influenced by written test, and the extent of influence. Finally, it gives suggestions on the proper percentage that written test should take up in a competition based on the extent of influence. This study adopts questionnaire survey and combines qualitative and quantitative research methods. The combination method is adapted from Saaty's column vector method [17]. This study selects only a part of the grades for data analysis. The distinguish itself from the column vector method, this study refers to its research method as lateral vector method (LVM). The grades are selected base on the $\Sigma 2^{n-1}$ formula where "n" refers to the last placement in terms of skills operation among gold medal winners.

1. Lateral Vector Method

The focus of this study is to figure out the extent of influence of written test on placements. Therefore, this study firstly matches the grades of written test and skills operation to analyze the changes in the overall placements. This step helps to get the lateral vector values (LV values) of three different levels. The three levels can be explained as: written test has a positive influence on gold medal (3), written test has a positive influence on silver medal (2), and written test has a positive influence on bronze medal (1), and written test has no influence on placements (0).

There are three major functions for adopting LVM: (1) to determine whether or not a given independent variable (for example, written test) is worthy to taken as a basis for competitions, (2) to analyze the extent of influence of the independent variable on dependent variable (the overall placements), and (3) to serve as a reference for adjusting the percentage of each of the independent variables (for example, written test and skills operation) in the training program based on the extent of influence.

The six steps for implementing LVM are as follows:

- (1) Find out LV levels: among the gold medal winners, find out whose skills performance is ranked the last and take his/her placement as LV level.
- (2) Figure out the maximum grade (M): Put the LV level (n) to the $\Sigma 2^{n-1}$ formula for quantitative analysis, the outcome is the maximum grade.
- (3) Decide LV evaluation scale: check up LV level (n) and the maximum grade on the LV evaluation table (Table 2) to find out the LV evaluation scale for that level.
- (4) Classify the level using the LV evaluation scale.
- (5) Calculate the LV of the given factor: calculate the ratio (%) of level classification to total number (N = level multiplies by the number of vocation fields).
- (6) Calculate the influence of LV of each of the placements. Put the classification of each of the placements into the LV matrix (level) to figure out the weight of each of the placements, then multiply LV by the weight of each of the placement to find out the extend of how each placement is influenced. The formula is as follows [17]:

$$W_i' = \frac{1}{n} \sum_{j=1}^n \frac{a_{ij}}{\sum_{i=1}^n a_{ij}} \quad i, j = 1, 2, \dots, n$$

Where: W=weight; W_i' =Vector;
n=grades; a_{ij} =average;
 i, j = column & row

Table 2. LV Evaluation Scale (Three-level LV)

Levels \ Grades (n\M)	1	2	3
2	2→1		
3	3→2	2→1	3→1

P.S.: This table is developed based on the matrix of Saaty (1994).

2. Data Analysis

This study analyzes placements in relation to gold medal based on the research purpose. It firstly transforms grades into placements (continuous variables into ordinal variables) and then runs t-test on written

test and competition outcome. The result is shown in Table 3.

Table 3. t-test Matrix of the Top Four Placements of the 2010 Skills Competition

Evaluation Items	Written Test Placements	Skills Operation Placements	Overall Placements
Written Test Placements	1		(0)
Skills Operation Placements	0.211	1	
Overall Placements	0.523**	0.796**	1

* $p < .05$; ** $p < .01$

Table 3 shows that written test and skills operation placements do not reach the significant level, suggesting that there is no correlation between the two items, which is consistent with the basic hypothesis of the LVM [17]. Whereas written test placements and overall placements reach a significant level at 0.05, suggesting that there is a correlation between the two items. As for which placements are correlated, more LV analysis is required.

3. Data Analysis of the Overall Grades of the 2010 Engineering Skills Competition

This study follows the steps of the LVM (coding the data into Excell software and calculating the weights) and discovers that there were 14 vocation fields and 17 contestants influenced by written test in the 2010 competition. The LV is the ratio between “the number of contestants affected on each level” and “total number of contestants” ($N = 96$ contestants = the top four placements multiplied by 24 vocation fields), which is $17/96$ or 17.71% (meaning that written test has 17.71 % of positive influence on the performance of competition). Next, this study compares the percentages taken up by written test and skills operation to get the ratios influenced by written test. In this step, this study calculates the ratios of the number of influenced vocation fields to the total number of vocation fields in groups adopting different percentages of written test / skills operation. Table 4 shows that among the five vocation fields categorized under the written test / skills operation percentage of 1/9, only one vocation field whose overall placements are influenced by written test, so the number is shown with 1/5.

Table 4. The Statistic Analysis of Each Cluster Affected by the Proportion of Written Scores in 2010 Academic Year

Clusters of Written Test / Skills Operation Percentage	The Number of Influenced Vocation Fields	The Total Number of Vocation Fields	The Ratios Influenced by Written Test
1/9 Cluster	1	5	$1/5 = 0.2$
1.5/8.5 Cluster	1	1	$1/1 = 1$
2/8 Cluster	10	12	$10/12 = 0.83$
2.5/7.5 Cluster	1	2	$1/2 = 0.5$
3/7 Cluster	1	2	$1/2 = 0.5$
4/6 Cluster	2	2	$2/2 = 1$

This study feeds the ratios influenced by written test (0.2, 1, 0.83, 0.5, 0.5,1) and percentage of written test (1, 1.5, 2, 2.5, 3, 4) into Excel and figure out the correlation coefficient between the two is 0.4049. It is also discovered that in the clusters of 1/9 and 1.5/8.5, only two out of six vocation fields are influenced by written test (the ratio influenced by written test is 2/6 or 33%), whereas the other four vocation fields are not influenced. On the other hand, in the clusters where written test / skills operation takes up over 20%, over 70% of the vocation fields are influenced by written test (the ratio influenced by written test is 15/21 or 71.43%). The result shows that the lower the percentage of written test in the competition, the less influence it has on the overall placement, and vice versa.

Lastly, this study uses average of normalized columns mentioned above to figure out the weights from the first to the fourth placements are 0.5602, 0.2784, 0.1055, and 0.0560 respectively. Next, it multiplies the LV value (17.71%) by the weights to get the values of influence, which are 9.92%, 4.93%, 1.87%, and 0.99% respectively.

The LV value can be explained as “written test has 9.92% of influence on the first placement,” “written test has 4.93% of influence on the second placement,” “written test has merely 1.87% of influence on the third placement,” and “written test has only 0.99% of influence on the fourth placement.”

IV. Conclusions and Discussions

1. Research Findings

This study adopts stratified sampling and issues questionnaires to schools participating in the competitions. The focus of the survey is on the percentages of written-test training each of these schools has. There are 158 valid questionnaires for the return rate of 53.7 %. It is discovered that only 48% of the schools include written test into their training programs, and those which do include written test do not train it systematically. If schools want to win more medals, it is suggested that they include written test into the training and implement it in a systematic manner.

After analyzing the data with LVM, this study obtains the following outcomes:

- (1) Nearly 60% (14 out of 24 vocation fields) of the placements of all vocation fields are changed due to the influence of written test, showing that written test is very important in the overall competition process.
- (2) More than 70% of the vocation fields whose written test/skills performance ratio is over 20% are influenced by written test (extent of influence is 15/21 or 71.43%). On the contrary, only 30% of the vocation fields whose written test / skills performance ratio is less than 20% are influenced by written test (extent of influence is 2/6 or 33%). The finding shows that the higher the percentage of written test in the competition, the more the influence it has on the overall placements, and vice versa.
- (3) Nearly 18% (LV value = 17.71%) of the contestants are positively influenced. This LV value is close to the 20% that written test takes up in the competition, so it is worthwhile to conduct further research.
- (4) In the LV value, written test has 9.92% of positive influence on the first placement, and it has nearly 4.93% of positive influence on the second placement. However, written test has only 1.87% and 0.99% of positive influence on the third and fourth placements respectively.
- (5) After using LVM to analyze the placements, this study discovers that the higher the placement, the more it is influenced by written test.

2. Discussions

The preliminary survey of this study discovers that only 48% of the schools include written test into the training program of such an important competition. From the research perspective, enhancing the training of written test will not only increase the possibility for contestants to win medals but also increase students' motive to learn [18], which is one of the major purpose to organize a skills competition. Recent research literature also shows that such an effect of increasing the motive to learn can also help students with poorer achievement to increase their learning motive [19].

From the educational perspective, a competition is a process to achieve a certain purpose and a means to stimulate an individual's potentials. In short, a competition is a powerful driving force to trigger the inner motivation to learn [18]. Regarding this, governmental agencies and schools of various levels try to organize different types of competitions to encourage students to broaden their knowledge and sharpen their skills [20]. In addition, instructors play a critical role in arousing students' interest in participating in competitions [21]. Regarding the fact that inner learning motivation can greatly improve contestants' skills performance [7], instructors can use peer learning to train contestants and increase their learning motivation [22].

V. Conclusions and Suggestions

This study proposes the following conclusions and suggestions based on the research findings:

1. Nearly 60% of the placements of all vocation fields are changed due to the influence of written test, which is playing as a very important role in the competition process.
2. 71.43% of the vocation fields whose written test/skills performance ratio is over 20% are influenced by written test. On the contrary, only 30% of the vocation fields whose written test/skills performance ratio is less than 20% are influenced by written test. The finding shows that the higher the percentage of written test in the competition, the more the influence it has on the placements, and vice versa.
3. Nearly 18% of the contestants' placements are positively influenced. This LV value is close to the 20% that written test takes up in the competition, so it is worthwhile to conduct further research.
4. In the LV value, written test has nearly 9.92% of positive influence on the first placement, and it has 4.93% of positive influence on the second placement. However, written test has only 1.87% and 0.99% of positive influence on the third and fourth placements respectively.
5. After using LVM to analyze the placements, this study discovers that the higher the placement, the more it is influenced by written test.
6. It is highly suggested that contestants intending to win a gold or silver medal should include written test into their training program, and the percentage of written test training should be at least 18%.

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